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INTRODUCTION

TO

THE THEORY AND PRACTICE OF

BOOT AND SHOE MANUFACTURE

BY

FRANK PLUCKNETT

ASSISTANT MASTER, CORDWAINERS TECHNICAL COLLEGE, LONDON
FORMERLY INSTRUCTOR, MUNICIPAL TECHNICAL SCHOOL, LEICESTER
AND CHIEF INSTRUCTOR IN BOOT AND SHOE MANUFACTURE, MERCHANT VENTURERS' TECHNICAL COLLEGE, BRISTOL
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1916

PREFACE.

THE scope of the following pages is limited to the consideration of such processes as are of general utility in the manufacture of the usual lines of work, omitting such as would only occur in special classes, *e.g.* the slipper trade or nailed goods, excluding also those hand operations which are peculiar to the bespoke trade—long work, etc., as demanding fuller treatment than could be accorded in a single volume; moreover, where operations are more efficiently performed by machine, the corresponding manual methods have not been described.

It may be observed that photographs of complicated machinery have been omitted. This course has been adopted on the conviction that they serve no useful purpose: if the reader is already familiar with a particular machine he does not require an illustration; on the other hand, if he is unacquainted with it, he will derive very little benefit merely from a small photograph from one side. Thus it is obvious that in any case such plates would only occupy valuable space without offering any appreciable advantage in return.

An attempt has been made to provide the technical student with a clear conception of the fundamental ideas underlying the processes of the trade; with a firm grasp of these, he should have no difficulty in dealing with the problems which are inevitable in a progressive industry.

It is hoped that this volume will prove useful not only to students in technical schools, for whom it is primarily intended, but also to the large circle of those who are interested in the rapid modern developments of the industry, and who have not the advantages of technical instruction.

Of the appendices, that dealing with the Lever needs no comment, but the one on Geometry must only be regarded as the irreducible minimum required to work the particular system of pattern-cutting employed in the text. The Index has been made as comprehensive as possible, in order to facilitate casual references.

Where the ground has been covered by previous authors, their works have been freely consulted

F. P.

LONDON, *March*, 1916.

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CHAPTER I.

THE ANATOMY OF THE FOOT.

1. ALTHOUGH a knowledge of the anatomy of the foot is not essential for every one engaged in Boot and Shoe Manufacture, yet it is very useful when trying to solve many of its problems.

To facilitate a detailed description of the bones we shall refer to one end of each bone as the *head*, and the other end as the *base*; the length of bone between these being called the *shaft*; the part of a bone which is nearest the toes is the *anterior* part; while that which is nearest the heel is the *posterior*.

The surface of a bone differs from its other portion in being much harder, and finer in texture, but it is by no means uniform in its character, for those parts which fit against another bone, or which serve to guide a muscle, or any part which rests upon a ligament, are very much harder and have a finer surface; on examining skeletons it may be observed that these portions do not so quickly yield to decay.

Where two bones fit against each other, the surfaces are said to be *articulated*, although they never actually touch since they have between them a layer of *articular cartilage* which serves three useful purposes:—

(*a*) It is firmly attached to the bones and holds them in position;

(*b*) It saves the friction and wear which would result from two hard surfaces working against each other;

(*c*) It reduces to a minimum the shock which otherwise would be experienced in putting down the foot quickly.

2. There are twenty-six bones in the foot and these are generally considered as forming three separate groups:—

In the *Tarsus* there are seven bones:—

(1) The *Os calcis*, sometimes called the *Calcaneum* or heel bone;
(2) The *Astragalus*, or ankle-bone;
(3) The *Scaphoid*, or boat-shaped bone;
(4) The *Cuboid*, which somewhat resembles a cube;
(5-7) Three *Cuneiform*, or wedge-shaped bones.

The *Metatarsus* is the second group of bones and includes those which are "beyond," or immediately in front of the *Tarsus*; it contains five bones known as *Metatarsal* bones, being distinguished from one another by number, commencing from the inner side of the foot.

The *Phalanges*, or toes, comprise fourteen bones which form the third group; the great toe has two phalanges, but each of the others has three, the first phalanx being that nearest the metatarsal bone.

In the leg—that is, the part between the knee and the astragalus—there are two bones; the *Tibia,* or shin bone, which rests upon the astragalus, its base forming the ankle-bone which is on the inner side of the foot, and the *Fibula,* or clasp-bone, which also rests upon the astragalus, its base being the ankle-bone which is on the outer side of the foot.

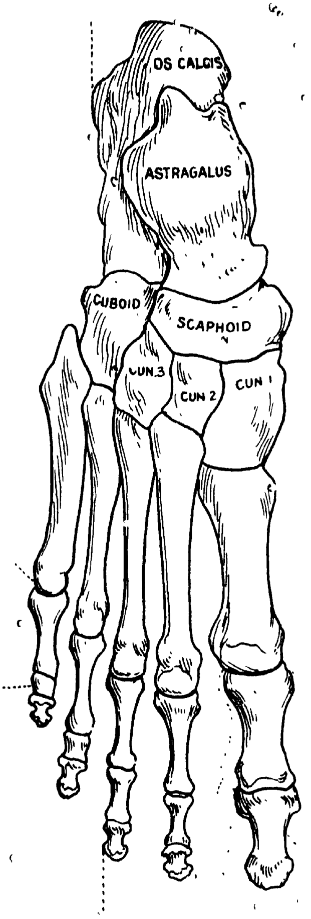

FIG. 1.

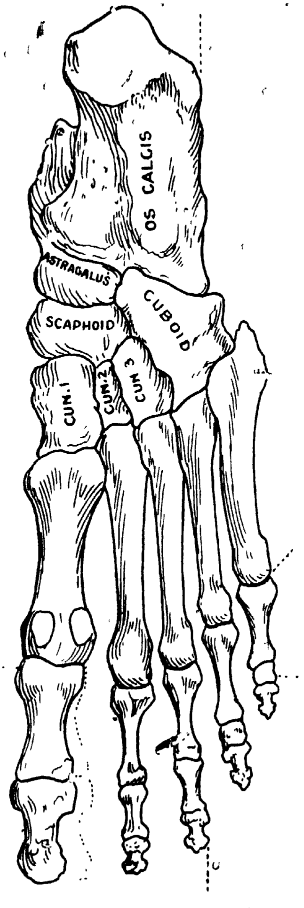

FIG. 2.

The shape of many of the bones is so irregular that no description, however, full, could convey an accurate knowledge of their form; diagrams are therefore given of—

Fig. 1.—The foot, seen when looking down at it,

Fig. 2.—The foot, looking at it bottom upwards;

Fig. 3.—The foot, looking at the inside waist;

but the reader is recommended to study a real skeleton if possible.

3. In fig. 3 it may be noticed that the posterior portion of the calcaneum rests upon the ground—the anterior part does not—and forms the commencement of what is known as the longitudinal arch of the foot; this arch is continued by the head of the astragalus, where the arch reaches its greatest height from the ground, and then by the scaphoid, the first cuneiform bone, and the first metatarsal bone, the head of which forms the anterior end of the arch. The principal factors in keeping this arch in position are:—

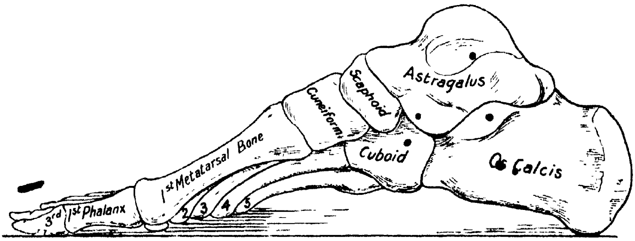

FIG. 3.

(*a*) The *Plantar ligament*, which extends from the base of the calcaneum to the extremities of the metatarsal bones;

(*b*) The *Calcaneo-scaphoid* ligament (attached both to the calcaneum and the scaphoid), which supports the head of the astragalus; when this ligament becomes weak through any cause it is unable to support the weight of the body transmitted through the astragalus, the head of which therefore sinks down, causing the longitudinal arch of the foot to disappear — the defect being known as "flat foot" (see § 6, Tibialis posticus).

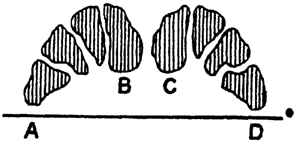

FIG. 4.

Fig. 4 is a representation of a cross-section of the feet through the cuboid and the three cuneiform bones; the *transverse arch* of the foot can easily be traced (A to B), the wedge-shape of the second and third cuneiform bones being very pronounced. The bones are always held together by articular cartilage, with the assistance of strong external ligaments.

A second transverse arch is formed by the two feet, the outside of each foot forming one of the extremes of the arch, its highest part being at the inside waists marked B and C. The arches of the feet are of great importance:—

(i) A longitudinal arch makes an elastic step possible, hence this vanishes when the arch disappears; it also reduces the shock which otherwise would be experienced when walking.

(ii) The transverse arches being highest on the inner side of each foot, elasticity is thereby secured with the minimum loss of strength, since the other foot comes to the aid of the first, should it be unduly strained; but this assistance would not be forthcoming if the highest part were on the outer side of the foot.

(iii) The value of the arches in protecting the blood-vessels and muscles from the pressure of the weight of the body can scarcely be overestimated; it is a designed protection which should never be lessened by making the boots so arched in the waist that the free play of the muscles is restricted, or the circulation of the blood impeded (see § 26).

4. Most of the muscles of the foot may be grouped under two headings, (*a*) *Flexors*; (*b*) *Extensors.*

The *foot* is said to be extended when it makes a more or less straight line with the leg, and to be flexed when the toes are drawn toward the knee. The names of the muscles must not however be associated with these movements, because those which are in the sole of the foot and whose contraction causes the foot to be in line with the leg, are called flexors *because they flex or bend the toes*; while those which are upon the top of the foot and the contraction of which brings the toes towards the knee, are called extensors—*they straighten the toes.* The great toe has six muscles:—

(i) *Flexor longus pollicis*, or the long flexor of the great toe, is connected to the underneath side of the last phalanx of that toe, and passes under the anterior end of the first metatarsal bone, where it passes between two little bones named *sesamoid* bones, which are similar in size and shape to very large green peas; this arrangement enables the muscle to move freely, which it would not do if it were pressed upon by the weight of the body. The muscle is continued through the longitudinal arch of the foot, after which it passes at the back of a process—this signifying a part which projects out—on the inner side of the calcaneum, called the *Sustentaculum tali*, the origin of the muscle being on the Fibula.

(ii) *Flexor brevis* (short) *pollicis* is attached to the under side of the first phalanx of the great toe and extends backwards until it joins the sheath of the peroneus longus.

(iii) *Abductor pollicis* is the muscle with which the great toe is drawn away from the toe next to it; this extends from the first phalanx to the side of the calcaneum.

(iv) *Adductor pollicis*, as its name signifies, serves to bring the toe back to the side of the second toe; its direction is through the centre of the sole of the foot until it joins the abductor pollicis; both then form one stem and finally join the sheath of the peroneus longus.

(v) *Extensor* (*longus*) *proprius* (special) *pollicis* is the only *special* muscle which this toe has on the top part of the foot; it has its rise at the second phalanx and is continued up the instep (its exact position can easily be located by forcibly contracting it) under the *annular ligament* (which is a broad band of cartilage passing from the base of the Tibia on the inner side of the foot above the instep, to the base of the Fibula on the outer side. The muscle then passes up the front of the leg, its origin being under the Tibialis anticus.

(vi) *Extensor brevis digitorum* which serves the great toe, and three others (see § 5).

5. The fingers can be moved independently of each other, but the toes cannot. The great toe can be moved without the others, since it is operated by separate muscles, but the other toes being operated by muscles having a single stem with four branches can by the will only be moved simultaneously.

Flexor longus digitorum, the long flexor of the toes, is attached to the underneath side of the third phalanx of each toe, except the great toe; the stem then passes back towards the heel through the hollow which is in the sole of the foot between the joints, it being thus protected from the weight of the body; thence it passes up behind the inner ankle just in front of the Flexor longus pollicis, its origin being in the Tibia.

By the muscle passing up at the side of the foot in this way the toes would be drawn in an oblique direction; to counteract this, where the Flexor longus digitorum divides into its branches another muscle is attached to it, the *Flexor accessorius*, and this afterwards divides into two parts, fixed one on either side of the heel. The toes having each three bones (except the great toe), it is evident that if the end ones are strained the middle ones would have a tendency to spring up; to prevent this and so give the second, third, and fourth toes more strength, there is attached to the second phalanges of these toes another muscle, the *Flexor brevis digitorum*, the stem of which passing down through the centre of the sole of the foot becomes a part of the *Plantar fascia* which is attached to the calcaneum.

The *Extensor longus digitorum* on the upper side of the foot has its branches attached to the third phalanx of each toe (except the great toe), while its stem, passing under the annular ligament, ascends the front of the leg by the side of the *Extensor proprius pollicis*, its origin being on the outer side of the Tibia.

The *Extensor brevis digitorum*, which assists in extending the toes, arises from the upper surface of the outer side of the calcaneum, its tendons unite with the tendons of the Extensor longus digitorum, the ends being attached to the first phalanx of the great toe, and of each of the small toes *except the little toe*.

The little toe has a small muscle—*Abductor minimi digiti*—which draws it away from the fourth toe; it is inserted in the outer side of the first phalanx and the outer side of the calcaneum.

Flexor brevis minimi digiti—the short flexor of the little toe—is attached to the first phalanx of the little toe and to the *long plantar ligament* which is attached to the calcaneum.

6. Besides the muscles which are used for the movements of the toes there are some which are necessary for the movements of the foot where it articulates with the leg at the ankle.

Attached to the back of the calcaneum is the *Tendo Achillis*—a tendon being a sinew,—which above the ankle is connected with the combined calf muscle,—muscle, strictly speaking, being lean meat. This is the most powerful muscle in the whole body; its contraction lessens the distance between the heel bone and the calf by raising the heel, and if the person is standing it raises the body so that its weight is supported on the toes without resting the heels on the ground.

To assist this action, support is given by the *Tibialis posticus*, which passes under the sustentaculum tali (§ 4) and is attached to the scaphoid and first cuneiform bones, thus helping to support the calcaneo-scaphoid ligament. The *Flexor longus pollicis, Flexor longus digitorum Peroneus longus* and *Peroneus brevis* also lend their aid in raising the heel.

7. If the heel is rested on the ground and the toes drawn upward toward the knee the following muscles will have been contracted :—

Tibialis anticus, one end of which is attached to the Tibia or shin bone, whence it passes under the annular ligament to the inner and under side of the first cuneiform bone and first metatarsal bone. The Extensor proprius pollicis and Extensor longus digitorum will also be contracted.

There are three *peroneal*—a Greek name for Fibula—muscles, all attached to the Fibula, or *Perone*.

Peroneus longus comes down behind the outer ankle, passes under the waist of the foot and is attached to the first metatarsal bone. *Peroneus brevis* also comes down behind the outer ankle, but *Peroneus tertius* comes down in front of the outer ankle, both muscles unite and are attached to the fifth metatarsal bone.

Transversalis pedis crosses from the head of the first to the head of the fifth metatarsal bone.

8. A general description of animal skin is given in § 109, but the skin of the foot differs from it in several details, and also differs in some places from the skin on other parts of the human body. On the top part of the foot the skin is not subject to friction—unless from artificial coverings—therefore it is thin and soft; it is also loose, so that the foot shall not be impeded in its movements. The skin on the sole of the foot has not the same characteristics; it is not loose, because this would make it difficult to obtain a sure footing; it is subject to friction and wear, consequently we may notice it has a tendency to thicken rapidly, the tough white fibres being in much greater proportion than usual, as they also are in the palm of the hand; the skin is not as tender as on the top part of the foot, except just behind the toes and in the waist of the foot. In other parts of the body the sebaceous or grease-forming glands keep the skin soft, but these glands are absent in those parts of the sole of the foot which are subject to friction, but sweat glands are very numerous.

9. *Corns* are caused by friction and intermittent pressure which

results in a thickening of the epidermis; naturally we find the greatest thickening where the cause is greatest, and this thickening adds to the irritation, which soon causes the papillæ beneath to become inflamed and enlarged, and the fact that they are the ends of nerves explains why corns are so painful.

Corns have no roots, and do not extend deeper than the papillæ, the white core often seen being only formed of dead cells, since the external layer of the skin at this place is too dry and hard for them to be thrown off in the usual manner. If the cause is removed the corns will soon disappear.

For the cause of bunions see §§ 13 and 14.

For the cause of hammer-toe see § 11.

10. Some remarks on levers will be found in Appendix I, and it may be of interest to trace the use of these in the action of the foot, When the ground is tapped with the toes, while the heel is off the ground, then the ankle forms the fulcrum and the contraction of the calf muscle at the back of the heel will be the power, the weight being the resistance of the ground which is tapped; hence it is a lever of the first order. When standing on tiptoe, the toes form the fulcrum, the weight lifted being that of the body transmitted through the astragalus, and the power principally that of the calf muscle assisted by the Tibialis posticus, Flexor longus digitorum and Flexor longus pollicis (see § 6); this being therefore a lever of the second order. If the heel is rested on the ground and a weight lifted with the toes, then the heel becomes the fulcrum, the weight being at the toes and the power that which is exerted at the front of the leg through the Tibialis anticus, Extensor proprius pollicis, and Extensor longus digitorum (see § 7), thus forming a lever of the third order.

11. The changes which take place in the foot from infancy to old age are very important to the shoemaker; they may be considered under separate headings as follows:—

In infancy the bones of the foot are very soft, being in fact not bone but gristle; therefore their shape may be considerably affected not only by hard shoes but even by wearing socks which are too short, since these not only prevent exercise and development, but also cause the toes to be distorted, and, if continued, this may result in *hammer-toe*, which is a permanent contraction of one of the tendons of the Flexor longus digitorum. Continued contraction of a muscle soon results in a permanent contraction, and therefore it is important that in infancy and childhood there should be room at the toes, both in the shoes and the hose, for natural exercise and development.

If a child falls it does not break its bones because they are not brittle, but in old age a very slight jar may cause a fracture, the reason being that as the child grows, earthy salts—principally phosphates of calcium—are deposited in the bones, and as the mineral matter increases so the bones become more and more brittle. The bones also change their shape as age advances; they do not appear to contract much in length—that is, in the direction of the length of the cells, which can easily be seen with

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9. *Corns* are caused by friction and intermittent pressure which

(*a*) The straightness of the line from the outside of the heel to the outside joint, which should be faithfully reproduced in the last.

(*b*) The position of the arches in the waist, where there is no impression from the foot, causing the shape to be so unlike the shape of the foot as seen from above.

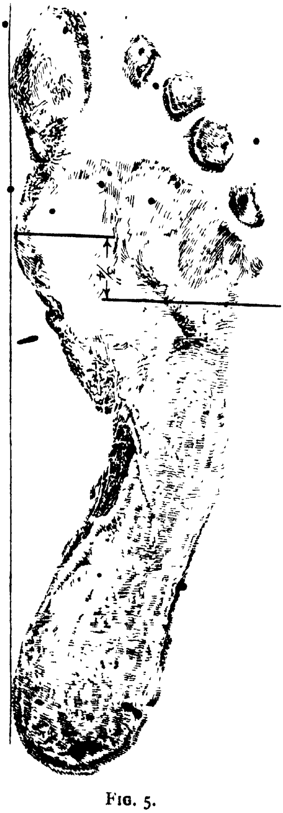

Fig. 5.

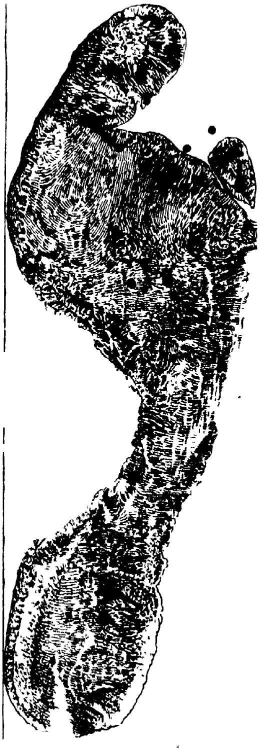

Fig. 6.

(*c*) The shape of the heel part, which from the centre of the waist to the back of the heel is more or less symmetrical about a line drawn down the centre of this part of the foot.

(*d*) The bold curve made by the outside margin of the smaller toes.

(*e*) The position of the inside joint in relation to the length of the foot.

(*f*) The straight line drawn from the great toe by the side of the joint back to the side of the heel.

This line has been the subject of much discussion, because opinion differs so much as to which is the "line of muscular action," and which the correct positions of the feet for walking and standing. Many doctors consider that the correct position of the great toe is that shown in fig. 5, since it would give a straight pull for the Flexor longus pollicis from the second phalanx of the great toe between the two sesamoid bones, back to the sustentaculum tali. Prof. Meyer of Zurich also argued that a line drawn through the centre of the second phalanx of the great toe should pass through the centre of the first phalanx and thence to a point in the centre of the heel; the great toe may take this direction when the weight of the body is supported on one foot, the Abductor pollicis having drawn away the toe to the full extent of possible movement, but it is doubtful if this should be considered to be the normal shape of the foot—the direction of the line in this case is that of the Extensor proprius pollicis. Mr. Golding considers the direction of muscular action to be identical with a line drawn from the centre of the heel through the length of the third phalanx of the second toe, but Dr. Camper affirmed that the toes are naturally parallel to a line drawn from the centre of the heel through the centre of the sole.

15. The correct way to stand and the correct way to walk are subjects on which much has been written. Dr. Ellis in "The Human Foot" argues in favour of what he names the "four-square position," shown in fig. 7: AB and CD are drawn from the centre of the heel to the centre of the forepart, the two lines being parallel; the military position of standing, however, is such that the insides of the feet form an angle of 45° as in fig. 8, and no one would suggest that this was adopted without consideration, or that having been adopted it would be retained, if the medical profession had been able to prove that there is a better way; even Ellis admits (p. 64): "In standing one instinctively inclines the feet at an angle in relation to each other".

16. Opinions differ more on how one should walk than they do on how one should stand. The different opinions should be considered under two headings:—

(*a*) Where the heel should descend.

(*b*) At what angle the toes should be placed.

According to Ellis, the Red Indian always places his heels on a line central with the body as in fig. 9. The late Dr. G. M. Humphry, Lecturer on Anatomy and Physiology to the University of Cambridge, in "The Human Foot" says: "When we walk the *heels* follow one another nearly in a straight line as is shown by walking along the line between the curb and the flagstone pavement". The wisdom of cultivating this style of walking—if it does not come natural—can at once be seen, because it saves the necessity of having to balance the body alternately on each foot, with each step; the difficulty of balancing increases with the distance the heels are placed from this straight line, and we all know how unsightly is the rolling walk which results. With reference to the angle at which the toes should be placed, Ellis adheres to the four-square position, so that the toes would be turned slightly inwards as in fig. 10; it therefore only differs from that of the Red Indian in that the feet are placed by the side of the centre line instead of being placed on it. F. Y. Golding, in "The Manufacture of Boots and Shoes," says that the foot should fall to the ground with the line which runs through

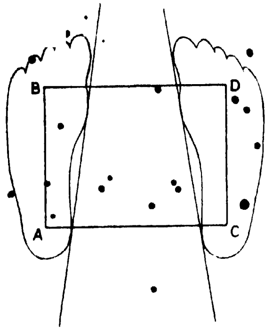

FIG. 7.

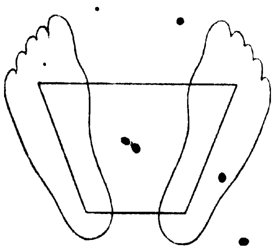

FIG. 8.

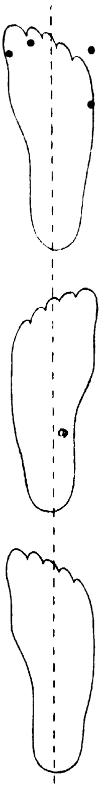

FIG. 9.

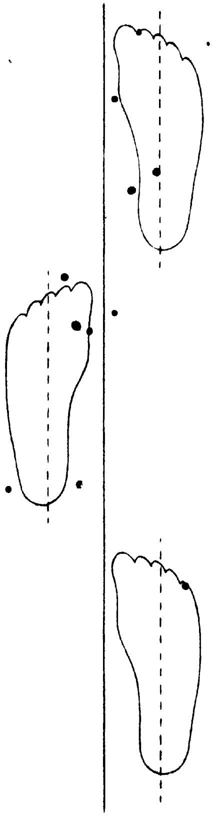

FIG. 10.

the second toe to the heel—the line of muscular action—"parallel to the line of progression". Professor Meyer advocated the toes being turned more outward, with the line—already described (§ 14) and known as Meyer's line—parallel to the line of progression. Dr. Camper tells us "the toes of a gentleman are always turned out"; and Dr. Humphry has said that "although the heels follow one another in line, the toes diverge a little from the line because the foot slants somewhat outward when it is placed upon the ground—*that is precisely the direction in which the foot is best prepared to receive the weight*". The method of walking which is adopted has generally been influenced considerably by the character of the footwear which was worn in childhood, the toes being turned outward in proportion to the stiffness and inflexibility of the bottoms of the shoes, unless sufficient spring is provided at the toe, as in the Lancashire clog.

17. The position of the inside joint—the place where the head of the first metatarsal bone articulates with the base of the first phalanx of the great toe—and its relation to the length of the foot is of very great importance because:—

(*a*) It is the anterior extremity of the arch in the waist of the foot.

(*b*) It is where the hinge action in the forepart of the foot takes place.

(*c*) It is where the sole shape will have its most pronounced curve.

Formerly it was deemed satisfactory to consider the inside joint as being at two-thirds the length of the last-length measured from the back of the last, but when extra length was given to the lasts (so that the toes could be made narrower) then the rule no longer applied. In the normal foot the joint-position will be at five-sevenths the *length of the foot* measured from the heel, although sometimes the measurement is given as seven-tenths of the length of the foot, the difference between the two measurements being one-seventieth of the foot's length.

It is not claimed that the joint always coincides with the position found by this rule (five-sevenths of the length of the foot), because if the arch of the waist breaks down, the heel bone will extend farther back than it did previously; there is also considerable difference in the total length of the two phalanges of the great toe in the feet of different people. The position also changes as the heel is raised, in which case the joints will move farther forward, about $\frac{1}{18}$ inch, for every $\frac{1}{2}$ inch the heel is raised (see § 35).

18. The position of the outside joint—where the fifth metatarsal articulates with the first phalanx of the fifth toe—is not quite so easy to locate because:—

(*a*) There is no irregularity in the outline of the shape of the foot to mark its position.

(*b*) The foot when on the ground rests along the whole of that side, there being no arch on the outside of the foot. The position where the hinge action takes place is not as far forward as at the inside joint. In a normal foot, size 4, ladies, as in fig. 5, it would be about $\frac{3}{4}$ inch farther back; *i.e.* $\frac{3}{4}$ inch between the transverse lines CD and EF drawn at right angles to the line GE, the direction of which is through the length of the second toe back to the centre of the heel (see § 23).

19. The width of the seat compared with the width of the forepart is very variable in lasts. I have before me an old pair of size 5, women's lasts, in which the seat measures $2\frac{1}{2}$ inches, and the forepart $3\frac{1}{3}$ inches,

the proportion being as 3 is to 4:[1] I also have a pair of lasts recently made, the seat of which is 2 inches, and the forepart $3\frac{1}{16}$ inches, this being nearly as 2 is to 3. The difference in the width of the heel in various types of feet is not so great as the difference in the width of the tread; and with the same width seat in differing types of feet the joint width may vary considerably; in addition to this it is the tendency of present-day fashions to afford more room than formerly for the joint to spread.

The difference between the width of the heel and the width of the tread in a normal foot, would be divided almost equally on either side of the line drawn between the second and third toes, but as the shape of most feet is more or less distorted through wearing boots, the proportions are liable to vary (see § 31).

20. In looking at the side of the foot and leg, the shape of some of the parts, and the location of others, should be studied.

When comparing many feet the observer would probably be impressed with the difference in the shape of the back of the leg. Two details contribute to this. In the side view of the foot (fig. 3) it may be seen that one part of the calcaneum forms the posterior of the arch in the waist of the foot, which arch, as already explained, is kept in this raised position only by ligaments and muscles; when these are in prime condition and the foot is a normal type the arch of the foot will be well developed and the extreme back of the calcaneum—where the Tendo Achillis is attached—will descend to the ground almost vertically; in this case people generally walk with quick steps, because although the distance is less between where the weight of the body is transmitted (the astragalus) and where the power is applied (back of the calcaneum), consequently requiring more strength, yet that which has been lost in power has been gained in speed (see Appendix I.). When the ligaments become weak and the arch of the foot descends, the heel bone changes its position and will now stand out at the back. The effect of this will be that the vertical line descending the leg through the centre of the ankle to the ground will change its relative position as regards the length of the foot and fall farther forward.

The other factor which influences the shape of the back of the leg so much is the development of the calf muscle. Exercise develops any muscle, but continued inactivity results in deterioration; walking—if the boots are sufficiently flexible—and dancing, stretch the whole calf muscle as the foot is flexed on the leg, and contraction takes place when the foot is extended on the leg as in raising on tip-toe; this exercise results in the whole of the muscle from its tendon (*Tendo Achillis*) to the insertion in the Tibia and Fibula being uniformly developed; and with a gradual curve, the girth of the leg will increase from the ankle to about two-thirds the length of the Tibia. It should be particularly noticed that the increase is almost entirely at the back of the leg, the front of the leg formed by the keen edge of the Tibia remaining unchanged. The calf muscle however does not always develop as gracefully as has just been described.

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[1] W. H. Mobbs in the "Boot and Shoe Trades Journal," 27 Nov., 1914, gives the width of the seat and forepart of the army last as $2\frac{1}{2}$ inches and $3\frac{1}{16}$ inches.

The wearing of boots with inflexible soles necessitates the foot being used without the calf muscle being stretched and contracted unless there is sufficient spring in the toes and freedom for movement at the ankle as in the Lancashire clog. If in addition to this the wearer has to stand many hours in one position, possibly doing something that causes the muscle to be kept strained, the result will be that just at the calf it will be abnormally developed, but just above the ankle it will be small.

21. The principal variation between feet of uniform length occurs at the tread. The length of a foot is not a guide to its girth measure, neither is the girth measure a guide to the width of the tread. Feet may be wide and slim, or narrow and thick; they may be bony with hard muscles or fleshy and soft.

To some extent each nation has its typical foot.

The Scotch have long, bony feet, well arched, and the inside joint rather large, toes broad, the heel measure and joint girth being large in proportion to the size of the instep.

The Irish feet are generally square at the toes, both the length and girth exceeding that of the English.

The English as a rule have long tapering toes, the average foot being neither as long nor as full as the Irish or Scotch.

The typical Welsh foot is short, but fairly full in fitting, and has these characteristics in both sexes.

22. There are factors which produce special types of feet.

The *character of the locality* for example. In hilly districts the calf muscle will be abnormally stretched in going up the hills, but in going down it will be abnormally contracted; this, more or less regular exercise, results in a well-developed calf from the ankle upward, the arch of the waist will also be high; but in flat districts this exercise is not obtained and these details are less developed.

Occupation and recreation exert considerable influence; dancing, running and jumping tend to develop the muscles and to produce the well-arched, nicely rounded foot and finely developed calf; whereas those who have to stand in one position for many hours, especially if at the same time the muscles are kept strained, only develop a large and often ill-shaped calf; the constant strain on the calcaneo-scaphoid ligament will weaken it, consequently the arch will descend and the heel bone project.

The footwear generally worn, also influences the type of foot. Heavy boots with inflexible soles prevent the free and full exercise of the muscles; consequently they become weak, and the ligaments for want of use are not as firm as they should be. When this results and the arch of the foot becomes flat, there will be an increase in the length of the foot, while the instep measure will decrease in its relation to the joint measure, the latter being often abnormally large.

23. E. J. C. Swaysland ("Boot and Shoe Design and Manufacture") classes feet under three types, according to the angle which the line drawn from joint to joint makes with a line passing between the second and third toes back to the heel; or, if in the normal foot lines are drawn through each joint at right angles to this length line, there should be a difference in their position equal to one-tenth of the length, *e.g.* in a foot measuring 10 inches the inside joint line would be 1 inch nearer the toe than that of the outside joint. Those feet having less difference would be classed in type one, but those with greater difference in type three, type two consisting of normally proportioned feet.

CHAPTER II.

THE FOOT AND THE LAST.

24. Dr. Ellis has said, "The last must be the shape of the foot," but while it must be accepted that there should be some relation between the two, yet no one with experience would think of taking a plaster cast of a foot and making boots or shoes on it, expecting that they would be satisfactory.

The following considerations determine the relation which the last should have to the foot:—

(*a*) The last must make sufficient provision for those parts of the footwear that will not stretch in wear, and for free play of the foot where necessary.

(*b*) The size of the last must be reduced at those places where the footwear will be most likely to stretch in wear, thus spoiling the fit and style. Material in the upper and method of making must be duly considered.

(*c*) Provision should be made for alteration in shape which would be likely to take place in wear (§ 25), *e.g.* springing the toe of the last.

(*d*) Refinement of form should always be studied.

(*a*) The heel part of the boot will not stretch because of the stiffener, and the seam will prevent any stretching at the toe-cap, therefore at these places there must be sufficient room provided.

(*b*) The joints are strong enough that together with the constant strain in flexing the foot they are generally able to stretch this part of the shoe in wear, therefore the measurement can be reduced by an amount equal to the probable increase.

The edge of the upper in a Court shoe grips the thin part of the foot below the ankle bone; it quickly stretches, although it is important that it should fit tightly, therefore the part of a Court shoe last where the top edge of the shoe would come must be considerably reduced. In a boot the corresponding part of the upper would be prevented from stretching by the leg, besides which the leg of the boot has to cover the prominence of the ankle, and it is not required that the upper shall fit so tightly under the ankle, therefore unless the last is larger here than in the one used for a Court shoe, the boot would be too small in the instep, heel and ankle measures.

The ordinary shoe can be made on a last which is between a Court shoe last and a boot last. The latter would cause the shoe to be loose around the top and too full on the instep, but the former would usually be too small at the instep.

(*c*) In a Court shoe there is nothing to prevent the waist of the shoe being pressed down, which would cause the shoe to gape at the sides, so it is usual to make the underneath side of the waist of these lasts nearly straight from the joint to the heel; the hollowing of the waist in a boot last has not such serious consequences (see § 26).

(*d*) The class of boot or shoe to be made, the style of manufacture and the fashion, are responsible for the different types of lasts, which may be grouped as follows :—

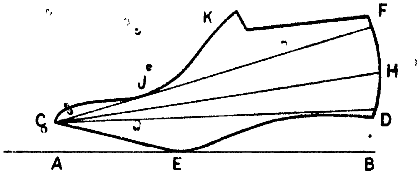

FIG. 11.

Gent.'s lasts for heavy work. These are rather larger than the measurements of the foot, because the material in the uppers would be too stout and hard to be stretched by the foot during wear; the waist of the last will be full, to admit of the expansion of the foot when supporting considerable weights; in addition, because the bottoms of the boots would be too stout and stiff to be straightened by the toes after being flexed by the foot in walking, it is advisable to put *spring* into the forepart of the last, equal to the amount which the boot would probably acquire in wear; this will prevent the uncomfortable and unsightly folds which would otherwise result between the toes and instep. By spring is meant the amount which the toe is raised above the ground line as at C in fig. 11.

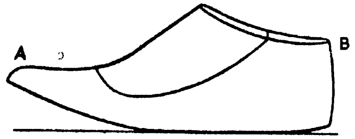

FIG. 12.

Lasts for *Gent.'s light work* will be smaller in the heel portion and across the joints because the boot could be worn tighter without discomfort; added to this, allowance can be made for some stretch. It will not be necessary to put so much spring in the toe of the last, because the bottom being much more flexible the toes should be strong enough to straighten it after flexion.

Lasts for *Gent.'s Court shoes* must be designed as described above, and as they may often be worn for dancing a close fit is indispensable. As may be seen from fig. 12 considerable spring is put in the toe of the last, the sole being light and flexible the toes can easily cause the forepart to lie flat on the floor; this is designed to have the effect of making the sides of the shoe clip against the foot, because springing the toe of the last has shortened the distance between A and B. The spring, however, should not be excessive or it will cause too much fullness behind the joints.

Last for Gent.'s slippers are designed for comfort, and are therefore made fuller in fitting, and larger around the ankle than Court shoes.

Boot lasts, *Shoe lasts*, *and Court Shoe lasts* have already been described. The Ladies' Court shoe last differs from the men's in that in the latter no provision is made for a heel, whereas the former will be designed to carry a heel which may be between 1½ inches and 3 inches in height.

25. To find what height heel a last is designed to carry, stand it on a level surface, then raise the heel part until the last rests on the joints, the waist of the last gradually rising from the joint to the heel as at ED, fig. 11. The distance DB plus the substance of the sole at the forepart will be the height which the heel should be and is known as the *pitch of the last.* The effect of raising the heel is to shorten the forepart, that is, from the contact point E fig. 11 to the toe C will be shorter, but as the heel is lowered more and more so a larger amount of the foot will be on the level of AB.

26. One of the most serious defects in modern lasts is the excessive arching of the waist, which apart from causing shoes to gape at the sides has also a serious effect on the foot, since the pressure caused on the waist impedes the free circulation of the blood, and hinders the exercise of the muscles in this part of the foot, the result being that the arch of the foot soon becomes weak. American lasts especially had this fault, and some idea of the extent of the harm done is indicated by a writer in one of their own papers—"American Shoemaking,' 8 January, 1910—who estimated that the business in arch-supporters and devices for remedying these foot troubles exceeds 5,000,000 dollars annually. It is a mistake to suppose that in lifting the heel the waist of the foot becomes more arched, on the contrary the muscles in the waist become strained taut with lifting the body, and the greater the strain the straighter will the waist become.

The waist of the foot underneath is very hollow on the inside but practically flat on the outside, and the last should be a faithful copy of the foot in these details.

27. The line CED in fig. 11 is sometimes termed the *range* of the last, although the term is also used in connection with the relative prominence of the outside joint; the line CED however is not the only curve in the bottom of the last, there being a transverse curve under the heel which serves two useful purposes, since it forms a cup which is more comfortable for the heel than a flat surface would be, and by centralizing the heel reduces its liability to tread over. In the

forepart there is generally a similar transverse curve, but the amount is very variable, sometimes the bottom being nearly flat; it is however generally conceded that making the bottom of the last convex assists the foot to keep in the centre, and thus lessens the tendency of treading over. There is also another important advantage since a considerable amount of the girth measurement can thus be provided for without increasing the apparent size of the finished boot.

28. In § 24 reference is made to the springing of the toe of the last, and it has been noted that boots which cannot be flexed by the foot should have sufficient spring provided by the last; two other factors have also to be considered when determining what amount of spring should be put in any particular last. The amount of flexing to which the boot will probably be subjected must not be overlooked; for example, coachmen's boots and hunting boots are not used for walking, hence they are rarely flexed in wear and since spring in the toe is not necessary it is usual to make such boots on lasts that are flat in the forepart. The other factor is the height of heel which is to be used, which is important, since if a high heel is used and a long stride is taken, when the heel is put down the top piece would be so far forward under the waist of the foot that it could not act as a pivot on which the weight of the body would be thrown over to the forepart of the foot, the result being that shorter steps must be taken, in which case the foot is placed flatter on the ground, the heel then not being so far under the foot. In proportion as the heel is raised so will the difficulty be increased, consequently the wearer will be obliged to take shorter steps, and since the boot will not be flexed so much in walking spring in the toe of the last will be less necessary.

29. The curve at the back of the last (DF in fig. 11) has been referred to in § 24. In shoe lasts this curve is more pronounced than in boot lasts; in the former CF will be about $\frac{3}{8}$ inch less than CD, but when the sides of the last have been thinned away—as in Court shoe lasts—the difference will be greater. The last should not be excessively curved in at F, because this would prevent the foot fitting back in the heel of the shoe at H, there would therefore be undue friction at F which would soon wear away the hose, and the shoe not having a proper grip at H would slop.

30. If a last is cut transversely at the instep it facilitates the study and comparison of the difference in shape between the two sides, and if several lasts of different types were similarly cut it would simplify comparison.

Lasts designed to follow the theory of Professor Meyer—that the line of muscular action is the course of the Extensor proprius pollicis and that the greatest muscular development takes place in connection with the great toe—have the ridge formed by the highest part of the instep, not in line with the centre of the width of the tread but much nearer the inside edge of the boot; while lasts which are designed according to Dr. Camper's theory have the instep central with the width of the tread; between these two extremes there is every conceivable variation. The position and shape of the instep will affect the shape of the whole of the back part of the last.

31. The shape and position of the end of the toe of the last must be considered when apportioning to either side the difference between the width of the heel and width of the tread. If the foot in question has *long tapering toes* and the last is similar in style, then it would appear that a much larger amount of the excess than usual would be required on the outside joint; if this shape is compared with one designed for a foot having a *long second toe*, possibly the great toe being forced out of its proper position (as in fig. 6), then the amount placed at either side of the line passing through the second toe backwards would be about equal; but theories as to how it should be apportioned in a correctly formed foot, and experience as to what generally is most satisfactory, will both be ignored while fashion decides not only the shape of the toe of the last but even where the toe shall be.

32. The amount by which the last should exceed the foot in length is very important, but before this can be considered we must inquire whether the length of the foot remains constant; on this point Dr. Ellis quotes from the writings of medical men (Camper and Parkes), who held the opinion that in walking the foot lengthens about one inch. The error probably arose through observing that it was necessary to make the boot longer than the foot, for otherwise in walking the toes would be pressed against the end of the boot. It is evident that when the boot is flexed in the action of walking, the sole of the boot (CED, fig. 11) cannot lengthen; *so the top part of the shoe must shorten*, the fullness gathering up at J, thus lessening the distance between C and H and making the boot shorter; in the foot however the bones retain their normal length in walking, but when the foot is flexed the fleshy covering on its bottom surface adapts itself to the slightly increased length of CED caused by flexing; *therefore it is not the lengthening of the foot but the shortening of the boot which has to be provided for.* It is often noticed that a boot which appears at first to be sufficiently long may after having been worn a few times be uncomfortably short, the explanation being that the boot had not the correct amount of spring in the toe. In wear —if the sole is not too rigid—the new boot will adapt itself as regards spring, retaining that amount of flexion which the toes are not strong enough to straighten, the shoe becoming permanently shorter between C and H according to the increased amount of spring. The shortening will be least in boots with very high heels, since the boots are flexed so little (§ 28) that the possible increase in spring must be small, and the shortening will be the greatest in those heavy boots where sufficient spring had not been provided in the last, because heavy boots cannot be straightened by the toes. If the length of the foot is taken when the person is standing, from 1½ to 2½ sizes would be allowed for ladies' footwear and 2 to 3 sizes for men's; when footwear with pointed toes is desired the allowance must be increased.

CHAPTER III.

LAST LENGTHS: ENGLISH AND FOREIGN MEASURES.

33. LASTS are measured for length in a straight line from C to H (fig. 11). *The English method* of registering the *standard length* of a last is by beginning at 4 inches from the end of the scale, this being called size 0; from this point onward $\frac{1}{3}$ inch counts one size; when $8\frac{1}{3}$ inches is reached—that is size 13—the numbering recommences, so that instead of size 14 we say size 1, and from here onward the figures run consecutively.

The *American scale* differs from the English by being $\frac{1}{12}$ inch shorter all the way through, beginning to count at $3\frac{11}{12}$ inches instead of 4 inches. *The French Unit* of measurement is the *Paris point* which equals $\frac{2}{3}$ centimetre; and as the centimetre equals ·3937 inch (which is nearly $\frac{2}{5}$ inch) it follows that the Paris point equals two-thirds of ·3937 inch, which is about $\frac{4}{15}$ inch, or fifteen sizes to 4 inches. In fig. 13 the scales are arranged side by side for comparison. It may be noticed that 10 inches equals ladies' size 5, English measure, and size 38 Paris points.

34. In the previous paragraph reference has been made to the *standard length* of a last; this refers to the size which it is marked. All lasts however which are marked the same size are not uniform in length. When it became the fashion to make the lasts very narrow in the toes it was evident that to secure comfort a longer shoe would be required, but as in many instances it would have been difficult to persuade the lady to buy a size larger than she had previously worn, last makers decided to use the same measurements as formerly for everything except the length, which was increased without restriction and without registering the amount. Whatever size the last is stamped if two and a half sizes are deducted—the average amount which the standard last will be over the length of a lady's foot,—then the inside joint should be at five-sevenths of the remainder, if measured from the back of the last. For example, if the last is stamped size 5, the *standard length* would be 10 inches; deduct $2\frac{1}{2}$ sizes (that is $\frac{5}{8}$ inch) and the remainder is $9\frac{1}{6}$ inches; $\frac{5}{7}$ of $9\frac{1}{6}$ inches equals $6\frac{23}{42}$ inches; the inside joint should agree with this if measured from the back of the heel.

35. From § 34 it will be evident that any attempt to find either the joint or instep position by its *relation to the entire length of the last* must result in error, and also that error must result from taking their

relative positions to the *standard length of the last unless the distances are measured from the back of the last* (H, fig. 11). The position of the inside joint being so important, and so very pronounced, it is probable that in the near future it will be not only the recognized position for determining the standard length of the last, but also for locating the position of the instep. As to the position of the latter, opinions differ considerably, but this can be easily understood since there is generally nothing of a very pronounced character either on the under or upper side of the foot to indicate its position; this enables us to appreciate the remark of Mr. H. W. Mobbs (of Mobbs & Lewis, last-makers, Kettering) in an address to the students of the City and Guilds of London Institute's Leather Trade School, on May 27, 1909, that "*The definite location of the instep is an unsolved problem, it cannot be either located or described in a single sentence*". Experiments in connection with the problem must be focussed around the foot—not the last—and the statistics as to its position should be tabulated so as to indicate either its relation to the entire length of the foot, or as compared with the distance of the inside joint from the heel. The inside joint position we have already considered in § 17 as being five-sevenths the length of the foot measured from an upright at the back of the heel, but in a last it is often described as being one-third of the standard length of a last *measured from a position on the toe of the last which would coincide with the standard length of the last.* If the length of the foot is $9\frac{1}{6}$ inches, then five-sevenths of this will give the joint position, measured from the heel ($6\frac{23}{42}$ inches); whereas if to the length of the foot $2\frac{1}{2}$ sizes are added to obtain the standard length of the last it would give $9\frac{1}{6} + \frac{5}{6} = 10$ inches, two-thirds of which is $6\frac{2}{3}$ inches, the difference between the joint position as located by the two methods being $\frac{5}{42}$ inch. If the length of the foot is taken with the

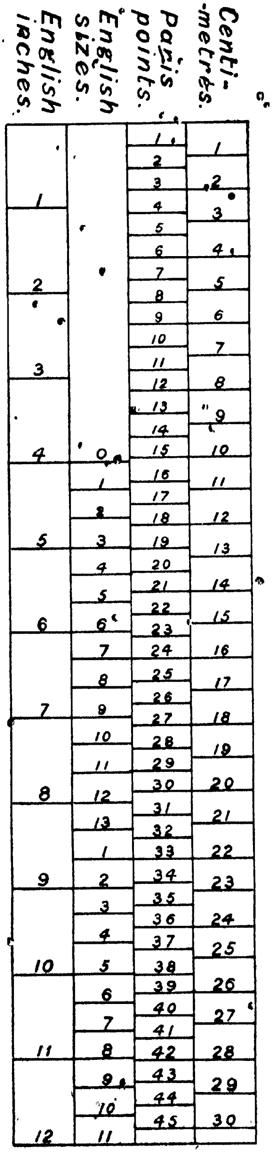

FIG. 13 (½ full size).

person standing, then an allowance of two sizes would be sufficient for the extra length of the last, and this would give the following result: length of foot 9⅓ inches; 5/7 of 9⅓ = 6⅔ inches; this result would coincide with the position being taken at two-thirds the standard length of the last, since ⅔ of 10 inches = 6⅔ inches.

36. The position of the instep on the last is not always determined by the same rule; sometimes for size 4 and sometimes for size 5 the instep is located at 2 inches above the joint position, but the amount, plus the distance from the joint, should be measured in a straight line from the toe without following the curve of the last.

A more reliable method of determining the instep position is to place the back of the last against an upright and then measure forward in the direction of the line CH (fig. 11), an amount equal to half the standard length of the last. The difference between the joint positions in any two consecutive sizes is 1/9 inch, this being one-third of the difference in the length of the two sizes; the difference between the two instep positions would be ⅙ inch, this being one-half of a size.

37. Lasts are made in six fittings, that is, with the same standard length of last varying widths of joint measure may be had, and *the relation of the joint measure to the standard length of the last denotes the fitting*, which may be denoted by letters as A, B, C, or by figures as 1, 2, 3. It is unfortunate that there is no fixed standard for the joint girth measurement of any one of the fittings, as is evident from the tables of measurement published by different last-makers; it will, however, be noticed that most of them allow ¼ inch difference between the fittings for the joints; for example, if the joint in 3 fitting is 8 inches, in 4 fitting it would be 8¼ inches. The instep measurement is not always uniform for the same joint girth (see table), nor do all last-makers allow the same amount of difference from fitting to fitting; generally the instep does not increase or decrease with the fitting so rapidly as the joint; sometimes ¼ inch is allowed from fitting to fitting, this being the same as with the joints, but ⅛ inch seems to be preferable and perhaps more general, the result being that the narrower the fitting the greater the difference between the joint and instep measures, and *vice versa*; this in practice is usually found to be satisfactory. The difference in measurement between consecutive sizes is usually ¼ inch as with the joints.

38. In § 12 reference has been made to the development of the foot from infancy to age, and to the difficulty of constructing a scale having a regular sequence of development all the way through. To meet the difficulty last-makers usually produce the lasts in sets, or ranges, as follows:—

Infants'	sizes	0 to 6,	7 sizes;
Children's	„	7 to 1,	8 „
Youths'	„	2 to 5,	4 „
Women's	„	2 to 8,	7 „
Men's	„	6 to 11,	6 „

About the year 1889, C. H. Alden, a last-maker of Norwich, prepared a scale by taking average measurements for women's size 4 joint and instep, and the same for child's 2½ size—this being exactly half the length of women's 4 size; between these two extremes there are 14½ sizes, the scale being produced as follows: Draw a base line and erect a perpendicular at one end equal to the height of a child's size 2½ instep—say 5 inches, and on the base line mark off 14½ distances (the number of sizes), commencing with the ½, which must be half the amount allowed for a full size; at the last mark erect a perpendicular equal in height to ladies, size 4 instep—say 8¼ inches: if a line be drawn at the top, then perpendiculars can be erected from each of the divisions, as in fig. 14, and will indicate the measurement for each size; by this method complete scales can be obtained for other fittings, or for the size of the joints. The data used by Alden for the different fittings are given in the annexed table:—

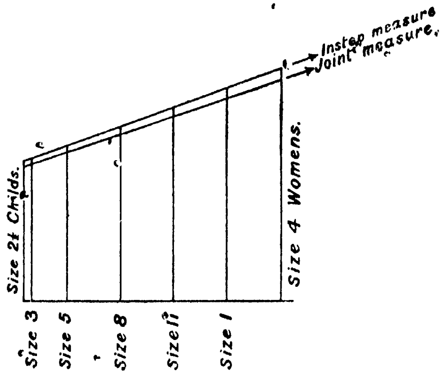

FIG. 14 (¼ full size).

	Size 2½ Infants'.			Size 4 Women's.		
Fitting.	Joint.	Instep.	Rise.	Joint.	Instep.	Rise.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
5	$5\frac{6}{64}$	$5\frac{14}{64}$	$\frac{8}{64}$	$8\frac{14}{32}$	$8\frac{22}{32}$	$\frac{8}{32}$
4	$4\frac{61}{64}$	$5\frac{7}{64}$	$\frac{10}{64}$	$8\frac{5}{32}$	$8\frac{15}{32}$	$\frac{10}{32}$
3	$4\frac{52}{64}$	5	$\frac{12}{64}$	$7\frac{28}{32}$	$8\frac{8}{32}$	$\frac{12}{32}$
2	$4\frac{43}{64}$	$4\frac{57}{64}$	$\frac{14}{64}$	$7\frac{19}{32}$	$8\frac{1}{32}$	$\frac{14}{32}$
1	$4\frac{34}{64}$	$4\frac{50}{64}$	$\frac{16}{64}$	$7\frac{10}{32}$	$7\frac{26}{32}$	$\frac{16}{32}$
Difference	$\frac{9}{64}$	$\frac{7}{64}$	$\frac{2}{64}$	$\frac{9}{32}$	$\frac{7}{32}$	$\frac{2}{32}$

Although such a scale may be desirable yet it is not often followed (see § 12). The difference between the joint measures of any two consecutive sizes in the same range is usually ¼ inch except for sizes less than size [illegible] women's, when it is not unusual for there to be only $\frac{3}{16}$ inch.

Tables for the joint and instep measures of men's lasts can be worked out from the following data :—

	Fitting				Fitting		
	3	4	5		3	4	5
	Inches.	Inches.	Inches.		Inches.	Inches.	Inches.
Size 8 joint . .	9	9¼	9½	Instep.	9½	9¾	10
Size 4 ,, Youths'	8	8¼	8½	,,	8⅜	8⅝	8⅞
Size 12 ,, Girls'.	6¾	7	7¼	,,	7⅛	7⅜	7⅝
Size 8 ,, Men's .	C	D	E	—	C	D	E
(American standard)	8¾	9	9¼	Instop.	9¼	9½	9¾

CHAPTER IV.

MEASURING THE FOOT.

39. MEASURING the foot is an operation that requires considerable judgment and care, otherwise misfits may result. To ensure satisfaction the following points should be observed:—

(1) The foot must be measured at the correct places.
(2) While the foot is in the correct position.
(3) The allowances which ought to be made should be stated.
(4) Special characteristics should be fully explained.
(5) The details must be recorded in such a manner that they can be understood by those to whom they are transmitted.

The measures may be taken with the person either standing or sitting, and with the foot either resting on the ground or lifted, and slightly extended, provided that the one taking the measures also fits the lasts, and always measures in the same manner. With experience, satisfactory results may then be obtained by either method; probably it is better to let the person stand, since the boot must be made large enough to allow for any expansion that may take place in the foot when it is supporting the weight of the body, and this expansion is not regular but varies with the strength of the foot, the occupation, and the weight of the person. A good method is to let the person stand on a board of suitable size, having at one end an upright; a sheet of paper being laid on the board the heel is placed in position against the upright; the foot should now be marked around with a pencil, inclined so that the outline does not show greater width than the foot actually has, as would result if the pencil were held perpendicularly, because the wood around the lead would cause the diagram to exceed the size of the foot by the thickness of the wood between the lead and the foot. It is not unusual to use a little block in the side of which there is a slot to hold the pencil at such an angle that the point of the lead will mark exactly at the outline of the foot; the broad base of the block also ensures that the pencil be always held at the same angle. When the outline has been marked, a pencil should be tilted to mark the hollowness of the inside waist. If the foot is carefully marked around in this manner then a size-stick may be dispensed with, otherwise it will be necessary to use one to determine the length of the foot with accuracy. The size-stick is simply a strip of wood—usually boxwood—having at one end an upright fixed at an angle of 90°, and a second upright at the same angle which can be moved along the whole length of the strip on which the sizes are marked instead of inches. It is customary in using a size-stick to take the length of the foot while the person is sitting, but this is unnecessary since the size-stick could easily be laid on its side, at the inside of the foot; this would do away with the uncertainty as to how much the foot might extend when supporting the weight of the body. While the person is still standing the measurement of the joint should be taken with a tape placed around the foot at right angles to the line passing through the second toe backwards (§ 16); when the joint measure is taken obliquely it is often unsatisfactory, because of the difficulty of again determining the same angle.

40. Marks should be made on the draft or outline of the foot, showing exactly where the measures were taken, both for the joint and the instep, the latter being at the most hollow part of the waist of the foot. Sometimes a waist measurement is taken between the joint and instep; it is usually ⅛ inch *less* than the joint measure, and should the joints be enlarged this measurement is important. The instep position can also be recorded with the size-stick by measuring its distance from the back of the heel as already described for the length; this position is important because from here to the bottom of the back of the heel is the proper place to take the long heel measure, which is very useful if special lasts have to be made. The ordinary heel measure is taken from the bottom of the back of the heel to the throat, *i.e.*, the front of the foot where the annular ligament is situated.

41. For the remaining measures it is more reliable to use two tapes, the unit ends being fastened together at right angles. The ankle measure is taken at the smallest part of the leg (which always occurs just above the broad base of the Tibia), using the two tapes to which reference has just been made, so that one tape registers the girth, and the other the distance from the ground at which the measure is taken. The leg measure should be taken in a similar manner at the height which it is desired to make the boot.

42. The amount of tension to use in measuring can only be learned by actual experience. People with soft fleshy feet can wear their shoes much tighter than those who have lean bony feet, and those with cold feet can do with a tighter fitting shoe than those whose feet perspire or swell, while those whose feet have not finished growing must not be measured with as much tension as can be used when measuring the fully developed feet of those in the prime of life. The character of the boots or shoes which are to be made from the measures must not be ignored; a shooting boot, for example, made from grained hide, will be subjected to a lot of wetting and drying, which will cause the leather to contract; the leather also is too stout and hard to be stretched by the foot in wear; added to which, because of the stiffness of the boot it could not be worn with so close a fit; measurements under such circumstances must be very easy or the boots will be too small. In contrast with the foregoing we may consider a glacé-kid upper with linen lining; this readily adapts itself to the shape of the foot and is so

soft that it may be worn without discomfort even though it be a very close fit; the boot should therefore be made less than the measurement of the foot. The method of making is also important; a boot that is to be hand-lasted and hand-sewn will not stretch as much in wear as a machine-lasted, Blake-sewn boot; but a sew-round would stretch still more, and allowance must be made for this.

Finally the customer's wishes must be consulted; one person is prepared even to endure discomfort for the sake of appearance, whereas another considers comfort to be the more important.

43. When greater accuracy is desired, or when conducting experiments, it is advisable that the heel should be raised an amount equal to the height of heel that is to be put on the shoe, minus an amount equal to the substance of the forepart of the sole; the instep, heel, ankle, and leg measurements would then be taken with the foot in the same position as when the boots would be worn.

Various forms of apparatus have been placed on the market with the object of reducing the probability of error in taking and recording the necessary measurements; the most useful is the "Pedograde" Machine, made by the Pedograde Company, Leicester. From fig. 15 a better conception of the machine can be obtained than from a description only. By moving the handle of the machine the tapes for the joint and instep are automatically moved to the correct positions for that size foot; it shows the type of last required according to the contour formed by the toes; the heel can also be raised according to the height of heel required on the boots to be made. If the order is then transmitted to a manufacturer having a similar machine, he can put his last on the machine and be certain that he is measuring it in exactly the same positions as where the measures of the foot were taken.

44. Impressions of the foot similar in style to figs. 5 and 6 are very useful in studying the different types of feet, and are the best guide for the last-maker in determining the shape of the waist of the foot. The following method is both clean and satisfactory: Procure an oblong frame about 14 inches long and 6 inches broad, over this stretch a piece of very thin sheet rubber; the framework should be thick enough that the rubber does not come into contact with any flat surface beneath it by about ¼ inch. The under side should now be thinly painted over with glycerine to which a little aniline dye has been added—printer's ink may be used if it is not too thick. To take the impression, place a sheet of clean paper beneath the frame and let the person stand on the sheet of rubber, which being depressed by the foot prints on the sheet of paper the exact shape of the depression.

Another method is as follows: A sheet of absorbent paper is damped with a solution of an iron salt—either ferrous sulphate or ferric ammonium sulphate; another sheet of paper is damped with a solution made from any of the tanning agents, or if these are not procurable commercial tannic acid may be used; the two damped sheets are placed together and if the foot is pressed on them for a few seconds the result will be a black impression on the paper, the foot not being soiled.

45. Sometimes it is desirable to have a cast of the foot, when orthopædic, or surgical boots are required. Plaster of Paris is generally used, the method being with more or less variation, as follows: A tray,

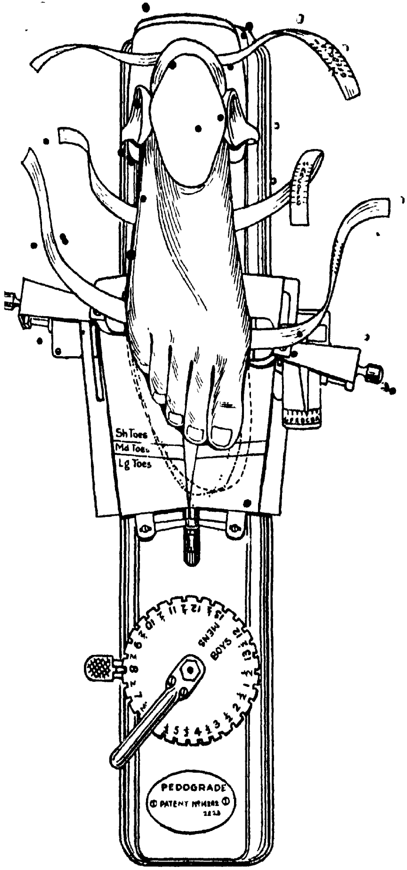

FIG. 55.

shallow box, or even a flat board if sufficiently large, will be necessary. Mix with a pint and a half of water (warm water is more comfortable to the foot) a sufficient quantity of the plaster to make a thick cream, and pour it into the tray; when this begins to set, the foot—which should have been carefully sponged with castor oil, or vaseline, to prevent the plaster adhering to it and to lay close to the skin any hair—should now be pressed into the plaster deep enough to reach the largest margin of the foot. The principle to be observed with this first operation is to take an impression of as much of the foot as is possible, bearing in mind that sufficient opening must be left to allow the foot to be withdrawn without spoiling the mould, the plaster however should be built up to the largest part of the inner ankle and at the back of the heel. When this part of the casting is set (which should not require more than three or four minutes) the foot can be withdrawn and the edges of the casting carefully cut square, so that when the next section is taken the parts will easily fit together. Now sponge the foot again to ensure that every part is greased, also the edges of the mould, and replace the foot in it, first however taking a long, well-greased piece of string which must be placed under the waist of the foot, and be brought up the leg, one end at the outer ankle, the other at the inner ankle. The plaster now mixed should be thicker than that which was used for the first operation, and must be built about the foot to the thickness of at least an inch, and as high above the ankle as it is desired to have the model; when this is set sufficiently, the ends of the string on either side of the ankle are drawn down, cutting through the plaster and causing the front section to separate from the back, after which the sections, as soon as sufficiently set, may be removed from the foot and put aside to dry.

When quite hard the three sections must be sponged on the inside, and then fitted and tied together; now mix a sufficient quantity of plaster into a cream and carefully fill the mould; the air must be allowed to escape or the model will not be perfect. This should be allowed plenty of time to set, after which the sections can be removed; it is not unusual for them to have to be broken as the model which has been cast cannot, like the foot, assist its extrication.

In taking casts of feet sometimes the heel is raised to the position it would occupy in the boot; for this purpose a rest for the heel, of suitable height, is placed in the mould.

It is not often that the student can, for practice only, find anyone willing to submit to the foregoing operation, besides which it involves a lot of work, and requires considerable experience, because the plaster sets so quickly, therefore the following method may be preferred; it necessitates a little extra outlay at first, but it has four advantages :—

(1) The student can practise on his own feet;
(2) Speed is not necessary;
(3) It is clean;
(4) There is practically no expense beyond the initial outlay, as the material can be used an indefinite number of times.

Procure a quantity of wax such as paraffin-wax or bees-wax, and soften it by adding sufficient tallow that at 98° F. the mixture is soft enough to be moulded to the foot. The higher the degree of temperature necessary to soften the composition the quicker will it set when making the mould. Having softened the wax in hot water, a double kettle or slow oven, and dusted the foot with French chalk, place the wax on a tray and mould it about the foot as described for plaster of Paris; when solid the edges can be dusted with chalk, next mould the front part of the foot and then the back. When the wax is quite hard the model may be cast in plaster of Paris as already described.

46. The difference which is usually made between the size of the last and the measurement of the foot will depend upon the circumstances under which the foot was measured—whether standing or sitting—and the tension put upon the tape when taking the measure (§ 42). Space prevents mentioning all the methods of measuring and the allowances for each method, but the following would generally prove satisfactory *if they were taken with the weight of the body upon the foot.*

In length a man's last should be two sizes longer than the foot; but if the last is narrow at the toe for that type of foot extra length must be allowed.

The joint measure for light work may be $\frac{1}{8}$ inch less than the foot; for medium substance work make to the measure, and for very heavy work $\frac{1}{4}$ inch over the measure.

The instep for light work may be $\frac{1}{8}$ inch less than the measure; medium substance work must be made full to measure, especially if for button boots; heavy boots $\frac{1}{8}$ inch more than the measure.

Ladies' lasts should be two sizes longer than the foot, unless they are in shape similar to the foot, and for high heels, in which case one and a half sizes are sufficient.

At the joints the lasts may be $\frac{1}{4}$ inch less than the foot for very light goods, $\frac{1}{8}$ inch less for medium substance, but for golf or similar boots make full to measure.

At the instep the last may be $\frac{1}{8}$ inch less than the foot for boots, and for shoes $\frac{1}{4}$ inch less, but it is advisable to inquire if the lady's instep is tender, and if she wishes the shoes to meet on the instep.

Boys' boots are generally made full enough to allow for growing both in length and girth.

47. Sometimes a last cannot be found that meets the requirements of the foot, and to save the cost of a special one being made the last nearest the description is used, and altered as may be necessary; this may be done either by reducing one that is too large, or by selecting a last that is too small and increasing the size by fastening on pieces of leather. A knowledge of the anatomy of the foot will now prove very useful, since it will explain the difference between the foot under consideration and the normal foot. When the last is not long enough it is advisable to put part of the amount at the heel and part at the toe, otherwise the position of the joints will not be correct. When the instep of the last is not large enough, the extra girth may be caused by the development of the fleshy part of the foot at the inside waist, and the fitting should be placed there unless there are indications from the draft that the foot is well arched, in which case the fitting may be placed on the instep. If all the fitting cannot be conveniently placed in the inside waist then the probability is that the abnormal development is where the Peroneus brevis and Peroneus tertius unite, and some of the

fitting can be placed there. It is generally at the joint, however, where lasts require most alteration, and the following are among the causes. The great toe may be forced out of its correct position as in fig. 6, the result being that the bones do not fit as closely together as previously; and as the space quickly becomes filled with a growth the girth measure will be increased.

Sometimes the underneath part of this joint is abnormally large, in which case provision can be made with advantage by putting a fitting on the bottom of the last, the correct place being determined by the draft; this makes the boot more comfortable than it would be if the extra measurement were added elsewhere, and it has the additional advantage that it does not increase the apparent size of the boot. When people have to stand in one position for many hours without having a rest, it results in the tendons becoming permanently lengthened, and, the ligaments being also strained, the bones of the foot will not be as closely braced together as formerly; in this case the increase in girth will be general and the fitting used should cover a large space, retaining as far as possible the general outlines of the last.

Provision for corns or hammer-toe can only be made by increasing the measurement just where it is required.

In addition to the foregoing, the last-fitter may be required to alter lasts so that they would be suitable for special types of footwear, in which case the lasts must be built up as described in chapter ii.

CHAPTER V.

PATTERN CUTTING.

48. ASSUMING that an upper pattern is required for a particular last the usual method is first to obtain, as far as is possible on a flat surface, a pattern that will fit the last; this is termed a *forme*—a French word signifying a "shape". Several methods have been tried by which to obtain the forme, all of them agreeing in at least one detail, namely, that it is necessary to have seams down the front and back of the last; but the unlevel surface makes it quite impossible to cover the last perfectly with two flat pieces of material unless it has the ability to stretch over the prominences. One method, therefore, was to cut as accurately as possible to the shape of the last two pieces of leather—generally Basil; these were machined down the front and back, then wetted and moulded over the last, the leather being cut off close to its edge when quite dry. In this way exact copies of its two sides were obtained, but they were not satisfactory to use for patterns, because they would not lie flat, and so it was impossible to reproduce their shape in flat leather. There was also another great difficulty, namely, that the material of which the uppers were cut would stretch, as this had done (only in a less degree), with the result that the curves in the upper did not then coincide with the curves on the last—the upper in consequence being too large. As the results were so unsatisfactory the method has fallen into disuse.

Soule's system to obtain the forme is as follows:—

The last is very carefully marked down the front and back exactly where the front and back seams would be in a seam-to-toe pattern; it is then laid on a sheet of paper and a piece cut, large enough to cover one side of the last with a margin of about ¾ inch to spare; this paper is "mitred" around its edges and then fixed to the last with either drawing-pins or tingles, little pieces of leather being used as washers (see fig. [illegible]6); the mitres are now taken one at a time and laid over the lines drawn on the last, reproducing them on the paper, which must also be marked along the bottom where the edge of the insole would be. Even though the paper is so liable to twist when being tacked to the last that considerable practice is required, yet the results which can be obtained by this method are much more satisfactory than by the previous method. An improvement on the above is only to slit the paper just where it is necessary to enable it to be laid flat on the last, the slits being made perpendicular to the outline of the pattern, otherwise the marks made where the paper crosses the front line will not form a continuous curve. Generally four slits are required for the front line and two in the waist, but this will depend upon the curvature of the last. To mark the paper where it crosses the lines, hold it down with the thumb-nail on the line, then fold back the loose end and crease the paper on the line.

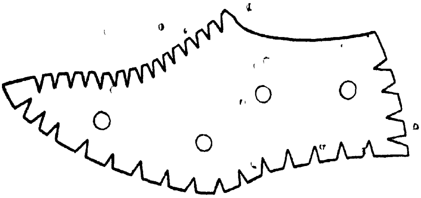

FIG. 16.

49. Those who have not acquired considerable skill will find the following method the easiest, quickest, and most accurate:—

First mark the last as already described, then take a piece of tracing-paper, or any strong, flexible paper which is sufficiently transparent that the lines made on the last can be seen through. Laying the last on the paper, cut a piece sufficiently large to cover one of its sides, then with a soft lead draw on it a straight line from about the counterpoint to the toe (AB, fig. 17); the paper can now be tacked on the last as already described, *care being taken to keep this line straight*; in this way

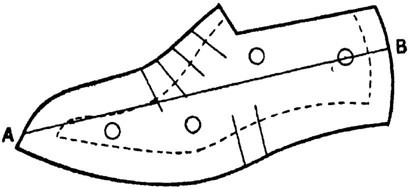

FIG. 17.

the slightest twisting of the paper would at once be detected. Where necessary slits can now be cut in the paper—perpendicular to the outline of the pattern—after which the edge of the paper can be laid over the lines on the last, which should be carefully traced with a finely pointed lead; this is not difficult if the pencil is suitable, the paper being transparent. In marking the back of the last inaccuracy at the bottom is not unusual; to avoid this see that the paper lies close to the last. When there is no plate on the bottom of the last, it is a good plan to take one of the insoles generally used on that last, and with it as guide, mark in the waist of the last; this is important when the pattern cutter is not acquainted with the style of insole used by a particular firm, because many manufacturers use insoles very narrow in the waist, and if this is not provided for, the uppers will be smaller here than they ought to be. In the absence of any other guide, the waist should be sketched in, making it three-quarters the width of the seat. When the tracing-paper is taken from the last it should be placed on the cutting board and carefully cut at the pencil lines.

50. Sometimes, because of the similarity of the two sides of the last, only one forme is cut, that being for the outer side; usually, however, formes are cut to both sides, and a mean forme, which divides the difference in their shape is cut as follows: Take the larger of the two formes and carefully mark around it with an awl on a sheet of clean paper (an awl being used in preference to a lead pencil since it is so much easier to retain a very fine point). The smaller of the two formes is now placed over the tracing just made, and this also is marked around; the backs should be placed as in fig. 18, the formes being together at the bottom corners; sometimes they are arranged as in fig. 19, the reason being that in marking the back of the last there is greater probability of the line being wrong at the bottom than at the top, on account of the sharpness of the last at the latter place; the top of the back of the last, however, is not always central; if it were, perhaps it might be better to arrange the patterns in this way, but if the last is carefully marked there should not be much difference between the two formes, unless the sides of the last differ considerably. With the front portion of the two formes it is usual to let them meet at the top of the puff. The difference between the two formes is now divided exactly in half, both up the front and down the back; sometimes it is also divided at

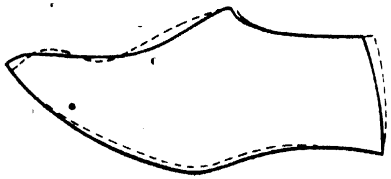

FIG. 18.

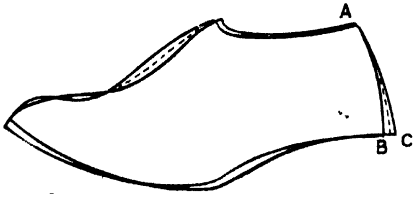

FIG. 19.

the bottom, this however is inadvisable because the larger of the two formes, if cut accurately, is none too large for that side of the last, if therefore it is reduced, the laster must use undue strain to stretch the upper, or move the front centre line away from its correct position on the last to enable him to obtain sufficient lasting allowance.

CHAPTER VI.

CUTTING THE BOOT STANDARD.

51. WHEN a *mean forme* has been cut it will be necessary to ascertain what height of heel the last is designed to carry, the method of doing this being given in § 25. The necessity of knowing it is evident, since it is so generally recognized that the front of the leg of the boot should be vertical when the heel is attached and the boot stood on the ground. When the leg of the boot stands vertical any alteration in the height of the heel would at once alter the inclination of the leg to the ground line. The usual method is to draw a base line as AB (fig. 21) and on its right hand side to erect a perpendicular, BC; let BD equal the height of the heel minus the substance of the forepart, this being subtracted because the inclination of the leg is not affected by that amount of the heel which is equivalent to the substance of the forepart; for example: If the heel measures 1½ inches and the forepart ¼ inch, then the back part of the last is raised only 1¼ inches, but if the forepart is ½ inch thick, then the heel has only been raised 1 inch; therefore put the corner of the heel of the forme at point D, generally called the pitch point.[1]

52. Sometimes the bottom of the forepart is allowed to rest on the base line AB, but by other systems it is arranged for the *joint of the forme* to cut the base line; this may be done either by marking on the forme the exact position and angle of the joint, or by marking on the base line the exact distance of the joint from B for that size, and also the angle of the joint line, then, placing the forme at D, its bottom edge would be allowed to cut the base line at the point found, as E.

The *counter-point* is a distance up the back of the heel equal to one-fifth of the standard length of that size last; for example: The standard length of size 5 women's last is 10 inches, one-fifth of which is 2 inches, this being the height of the counter-point for that size. By the former of the two methods for locating the joint, a line is drawn from the counter-point to a position on the front of the forme where the joint would probably come, from this point a line is drawn at an angle of 76°

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[1] The term *pitch*, which in the ordinary way means *to throw*, is unfortunately used to refer to several things. The amount which the back of the last is thrown up to accommodate the height of heel is known as the *pitch of the last*. The amount which the leg is thrown forward, *i.e.* its position on the length line of the pattern, is referred to as the *pitch of the leg*. The distance which the top piece is placed in front of the seat is spoken of as the *pitch of the heel*.

to the previous line. The method is open to the objection that as the height of the heel is raised so the angle of the joint line with the base line changes, it would therefore appear to be a more accurate method to determine what angle the joint line should make with the base line and then find its position on that line.

Don José Gonzalo in his work—translated from the Spanish in 1892 by W. H. Keel[1]—places the line at an angle of 80°, but later authors have varied it, gradually making the angle more acute. In studying the point it is useful to mark *on the last* the exact position and direction in which the joint would be measured, then, by using tracing-paper for taking off the forme, this line could be seen and marked on the paper at the time, this being transferred to the mean forme, its position being finally studied in the finished boot.

53. If it is decided to use a definite angle to the base line to obtain the joint line, then the next inquiry is, at what distance along the base line should it be drawn. In § 34 we have considered the joint as being

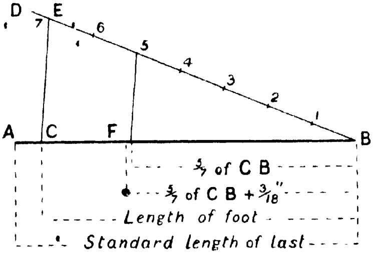

FIG. 20.

at five-sevenths the length of the foot; therefore now draw a line AB (fig. 20), equal to the standard length of the last being used, say size 4, which is $9\frac{2}{3}$ inches, mark off two and a half sizes, or $\frac{5}{6}$ inches representing the excess length of the last over the foot; this gives point C. To find five-sevenths of CB, draw a line at any convenient angle to it, as BD, then with the compasses and any radius mark off seven equal distances, naming the last mark E; if a line is now drawn from E to C, and *another line parallel to it* is drawn from the fifth mark, it will cut CB at exactly five-sevenths its length. Before this is transferred to fig. 21 some allowance must be made for a slight alteration in the position of the joints caused by raising the heel, it being found by experiment that the inside joint rides forward on the sesamoid bones about $\frac{1}{18}$ inch for each $\frac{1}{2}$ inch the heel is raised; therefore for a heel $1\frac{1}{2}$ inches high we mark forward $\frac{3}{18}$ inch as in fig. 20. If the foot is placed on the ground with the back of the heel against an upright and then the heel is raised it will be observed that the heel moves away from the upright, the distance increasing as the heel is raised; to provide for this in the pattern the distance BF in fig. 20 should be transferred to fig. 21, being marked off from D to where it cuts the line AB at E.

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[1] Leather Trades Publishers, London.

For actual practice a "tool" would be constructed as follows: The position of the joint for size 11 girls' is 5 inches, the difference between the foot and the last being two sizes, but for men's boots the difference between the foot and the last is three sizes, therefore for size 11 men's the position would be $7\frac{6}{7}$ inches; for the twelve intervening

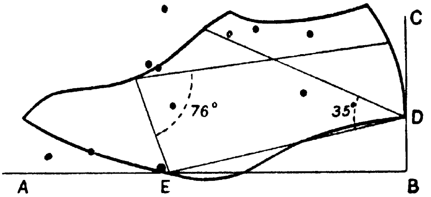


FIG. 21.

sizes the positions can be found by the method referred to in § 38. Having marked these off to the right hand from the *starting point* A, now from A, but extending in the opposite direction, as many eighteenths can be marked off as are likely to be required.

54. The position of the instep is the next consideration; its situation on the last has been referred to in § 36, but the length of the pattern differs from the standard length of the last, and alteration in the shape

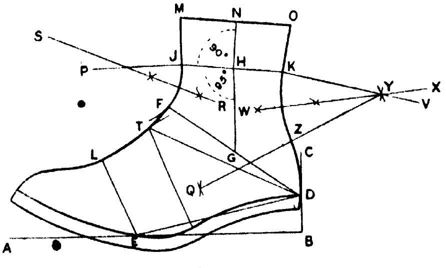


FIG. 22.

of the upper takes place during lasting, therefore it would not be practicable to determine the position of the instep by taking the same proportion of the entire length of the pattern, especially as its accurate location is important, seeing that from the instep to the corner of the heel (D, fig. 22), the long heel measure is taken. Having decided on the position of the instep on the last, we may resort to the same method as was used for the joints, *viz.*, mark the last, then use tracing-paper for the formes and study the position in the pattern; it will soon be evident from trial that if the line ED is trisected, then a line drawn from the first division and parallel to the joint line will coincide with the instep position as indicated on the forme. Gonzalo[1] located the instep with the long heel line which was drawn at an angle of 35° to ED (fig. 21); with lasts having a full instep this will often be found to give results identical with those obtained by the method previously described. The typical Spanish foot is well arched, but very many feet for which shoes are made in England have a smaller instep measure, and Gonzalo's system not being elastic does not adapt itself to suit other types of feet, therefore in the absence of two measures—long heel and instep—it is advisable to locate the instep by taking one-third of ED (fig. 22) and drawing the line parallel to the joint line.

55. In several systems of standard construction the heel measure has been located by taking it at an angle of 45° to ED, and when the type of last is such that the angle of 35° is correct for the instep, then 45° will be correct for the heel, but when the instep is too flat to be located by this rule then 45° would be too great an angle for the heel; it is advisable however to adhere to the 10° difference between the two lines; therefore, having drawn the long heel line to the instep, place the heel line at 10° higher, its correct position being important, since it points directly to the bend of the foot between the instep and leg. The length of the line for men's work would be about $\frac{3}{8}$ inch less than the long heel line, and about $\frac{5}{16}$ inch for women's if the long heel is located as described, but if found otherwise the difference between the two measures may vary. When lasts designed for shoes are to be used for boots then the heel measure would be too small if so much difference were made. In cutting upper patterns from foot measurements it is very important that it be ascertained whether the heel measure was taken when the foot was sustaining the weight of the body, in which case for very light flexible materials that are to be hand-lasted by the hoisting method this part of the pattern may be cut the same size as the measure; for medium substance work, machine lasted, $\frac{1}{2}$ inch is generally added; but men's very heavy work will require an allowance of $\frac{3}{4}$ inch including stiffener allowance.

56. From the centre of the heel line, a line GH (fig. 22), perpendicular to the base line should be erected; this forms the centre of that portion of the pattern which fits the small part of the leg just above the inner ankle. Its height may be found by taking half of the heel line DF and marking it off from G towards H from which point a line JK should be drawn making JHG an angle of 95° to GH. The length of the ankle line JK is often made the same as the joint measure of the last, at other times it is made two-thirds of the heel line FD; it will be seen, however, from § 22 that the size ankle which would be suitable for a particular district and class of footwear may not be correct for all conditions, but whatever measurement may be used it is always equally placed on either side of the point H.

57. From J upward the line is drawn vertically unless for abnormal

[1] *Op. cit.*

conditions, there being with natural physical development little increase in the size of that part of the leg which would be in front of GH, if that line was produced upward; the amount is therefore put on the back, $\frac{3}{16}$ inch being added for each inch increase in the height above the ankle line.

If a line be drawn from H at right angles to the ankle line JK a result similar to the foregoing will be obtained, NO being made equal to NM.

The designing of the throat requires some practice since the straight line from J to M must be connected to the instep of the forme by a curve which passes through F. The straight line JM must form a tangent to this curve, therefore if a perpendicular PJ is drawn to it the centre for the required arc must lie on this line, and as the arc must also pass through F, its centre must lie on the perpendicular bisector of FJ; therefore where RS and PJ cut will be the centre for the required arc. The short distance from F to T may easily be sketched in.

58. The line of the back below K must now be completed. The boot at this part must not be made to fit closely when the person is standing perfectly upright, since provision must be made for the alteration which takes place with the movement of the foot, the shape and size of which (just above the counter-point) change considerably when the foot is flexed on the knee, as may easily be tested by experiment; the shape of the leg at the back of the ankle being now much straighter, and when a boot is curved too much at the back, the foot being unable to make the boot straight, is forced farther forward by the curve, so that the foot does not then fit back into the heel of the boot. An examination of worn boots will indicate that this is a very common fault.

A ready method of designing the back curve is to select any radius as DQ (fig. 22), Q being about $\frac{1}{2}$ inch behind the instep line; from D and Z draw arcs that cut at Q; the back of the pattern from Z to D may be described from this centre; from Z and K with same radius draw arcs which cut at Y, from which centre complete the curve between K and Z. The point Z must be on the line QY, the two curves KZ and ZD will then blend, having a common tangent.

The amount of curvature necessary at the back of the pattern is considerably affected by the actual position of the leg in relation to the length of the pattern. When the instep is low and the heel extends backwards (as described in § 20) the leg position would not be required to be placed so far back; this is automatically provided for by the long heel line falling lower with that type of last, since the heel line also drops with it, and this causes the centre line of the leg to move forward.

Another factor which considerably influences the position of the centre of the leg is the elevation of the heel. As the back part of the foot is raised by putting a heel on the boot, so the distance between the contact point at the joint and a perpendicular dropped from the back of the heel is lessened, the front of the leg being nearer to a position vertically over the contact point. The necessary change in the pattern is automatically provided, because the point E is brought nearer to B with the increase in the height of the heel; the line DT also becomes more horizontal and the heel line FD being at 10° with TD is similarly affected, its centre G gradually falling further from the vertical line BC.

In lasts designed specially for boots it will generally be found that a line drawn from ½ inch below K towards D will be bisected where it cuts through the back of the forme; the effect of this is to produce a pattern with less curvature at the back, this being more satisfactory for boots that are to be worn in hilly districts or by those who use the calf muscle to its full extent.

59. In varying degrees the majority of leathers stretch, and this must not be overlooked by the pattern cutter; for if, as a result of taking the first draft strain over the toe, the upper stretches in length, then the curve of the instep of the pattern would not coincide with the corresponding part of the last; the long heel measure would also be increased, and therefore to make the upper fit on the "comb" or instep of the last, it may become necessary to last away more at the back than was intended. To prevent these evils the pattern is sometimes altered, the process being termed "drafting". One method is to take away from the instep an amount equivalent to the increase in size resulting from the foregoing; the effect being a decrease both in the long heel measure and the instep girth. Another method is to cut from the bottom of the pattern an amount which gradually increases from the waist to the back of the heel; if this method is adopted the amount should be taken off the forme, not off the standard, since in a boot this would cause the leg to incline backward too much.

Special drafting of the pattern, however, should not be necessary if it has been cut by the method already described, because in cutting the forme the paper both down the front line and along the bottom was not sufficiently full to allow it to lie down—it had to be slit; the upper therefore, if cut this size and shape, will have to be stretched a corresponding amount in the process of lasting to make it conform to the last; the effect of this should be to set up the desired tension.

60. Another factor which assists in causing the upper to fit the last snugly is the insertion of the "stiffener" or "counter" between the lining and the outer material; if the leather in the upper is light and likely to stretch it will not be necessary to make any allowance, but where stretch is improbable, full provision for the stiffener must be made. For experimental work a tape measure may be tacked to the toe of a last as at C, fig. 11, leaving its other end free; this fastening to the last will ensure the measurements always being taken from the same position; now register the size of the last in the following directions, C to F; C to H; C to D; a stiffener previously mellowed and skived is next moulded to the heel of the last, which should again be measured, then by subtracting the first measurements from the second it will be evident *how much must be allowed when full provision is*

necessary; it would probably be $\frac{1}{8}$ inch for women's and $\frac{5}{32}$ inch for men's. In medium substance work there will be some stretch, although possibly not sufficient, in which case the stretch must be adequately supplemented. The method of machining must also be considered, since work machined off the lining (§ 186) will stretch more than it otherwise would.

61. The possible effect on the leg position caused by adding a stiffener allowance should not be overlooked since it is equivalent to moving forward the whole of the pattern and increasing the back curve. The stretch of the material has a similar effect, so that the position of the leg may be much further forward in the finished boot than in the pattern. With the same material in the upper, and the same method of machining, the amount which the upper would probably be stretched must depend upon the method of lasting; this may be by any one of the three methods, "seats up," "seats level," or "hoisting" (§ 339), the effect being least by the first method and greatest by the last, but in each case the forward movement of the position will be in proportion to the amount which the upper is stretched; this being so, it is obvious that the difference in the amount of tension set up by different workmen is quite sufficient to make an appreciable difference in the completed work, *hence the difference in results which may be caused by uppers being of unequal length.*

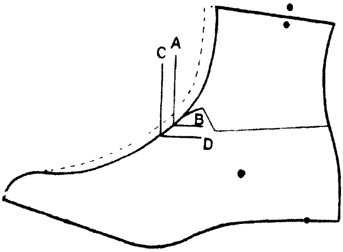


FIG. 23.

The factors which affect the position of the leg are many, consequently a pattern which may give excellent results under one particular set of conditions such as :—

(*a*) Kind of material;
(*b*) Method of machining;
(*c*) A particular length;
(*d*) One method of lasting;
(*e*) Drafting on a particular machine;

may not be as satisfactory should one of the factors be changed.

62. In connection with the inclination of the front of the leg the method of lasting the boot is a very important consideration since it has so much influence on the stretch of the upper, for the front of the last has a slope and the upper should fit tightly enough to prevent it gliding

down ; but when the upper is stretched in length so that A comes forward to C (fig. 23), then the apex of the angle AB will have to sink to the apex of the angle CD, before it rests on the last, and assuming there has been no alteration in the amount lasted down at the seat, then the effect would be to give a forward inclination to the top of the leg ; because of this it is usual to design the pattern with a forward inclination for "seats up" method of lasting and with a slightly backward inclination when the hoisting system of lasting is intended to be used.

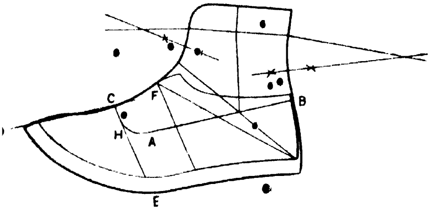


FIG. 24.

63. It is usual to add to the bottom of the standard an amount which is referred to as the "lasting allowance," which makes provision for the thickness of the insole and also provides the surplus necessary for the particular method of attachment.

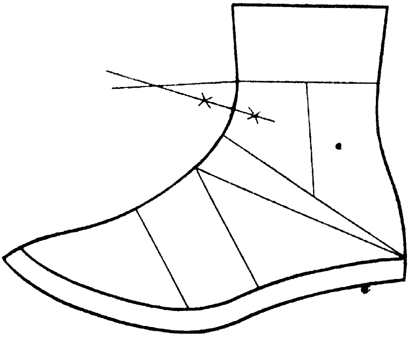


FIG. 25.

The allowance required for stout material is greater than that required for lighter leather, the amounts varying as follows :—

Handsewn, ¼ inch to ⅜ inch ;
Machine welted, ½ inch to ⅝ inch ;
Blake sewn, ½ inch to ⅝ inch ;
Men's heavy riveted, ¾ inch.

The system of standard construction that has been described will be found useful for men's and children's, as well as for women's work, as is illustrated by figs. 24 and 25; there should be a difference, however, in the character of each. Men's work is rarely cut so high in the leg as women's, and the girth measurements being greater even when the length measures are equal gives to the pattern a heaviness that is generally purposely avoided in women's footwear.

CHAPTER VII.

CUTTING THE PARTS.

64. When cutting the parts it is usual with a boot pattern to commence with the vamp—except in the case of a Derby, or quarter-over vamp—because its margin has such an influence on the appearance of the shoe.

The depth of the vamp at the front is generally decided by fashion, but when it is very long there is difficulty in removing the boot from the last, while it is still more difficult to insert the last again for channel closing and bottom levelling; besides this, it increases the task of putting the boot on the foot; consequently the deep vamp should be avoided in boots for elderly persons, or those who do not find it easy to stoop. When the vamp is deep its edge will cross the metatarsal bones, and there being little flesh at this part the pressure of the keen edge may cause pain. As the heel is raised the inclination of the metatarsal bones to the ground line is increased; this will be provided for in the last, but unless the vamp has been accurately cut there may be so much contraction when the last is removed, that in wear the boot will be very uncomfortable; therefore it is not advisable to design deep vamps for boots intended to have high heels, but with low heels little discomfort should be experienced. The vamp may be described as of normal length when its front coincides with the joint position.

65. The length of the wing of the vamp is important, as those will know who have had the misfortune to wear boots in which a seam came across the prominence of the fifth metatarsal bone. Behind this prominence the outline of the foot is formed principally by the peroneus brevis and peroneus tertius, and there being no bones immediately beneath the surface the pressure of a seam would cause no serious inconvenience, consequently if the bone referred to is avoided, the length of the wing becomes a question of appearance and expediency. The particular effect on the appearance must be decided by the design of the other parts of the shoe; but convenience is more important, since the seam comes in the waist of the shoe where there is little strain in wear; the vamp, however, requires the best of the material and to increase the length of the wing is to increase the proportion of the shoe which must be cut from the best part and thus to increase the cost and also to reduce the opportunity of using the poorer parts of the material where it would not be detrimental to the quality of the shoe.

66. Before discussing the other parts of the vamp, the shape from Q to A (fig. 26) must be considered; as there is no seam down the front of the vamp it will be necessary to cut both sides in one piece. To design the pattern first draw the line QA; but it will be observed that at R and beyond V it stands above the forme, and as all leather has some stretch (it being comparatively easy to stretch it over a prominence such as the toe of a last) do not use the line QA but draw a line QN which would be the position of the front line if the last was without a puff, then taking a position midway between the two lines draw a third line QP; it is of considerable importance to the laster which of these three lines is used when designing the vamp. If a straight edge be placed from A to L it will show a much deeper hollow at Q than would a line from N to L, and this hollowness (A to L) enables the laster to bring the upper to the last at this part with the minimum difficulty; but there is also another consideration, that is, the excess amount of material which the laster must dispose of around the toe. If a point is fixed where the side of the cap would come

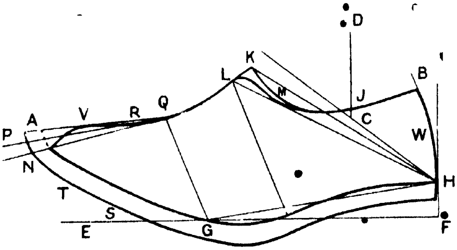


Fig. 26.

—as S, fig. 26—and the curve measured from that point past T to each of the three lines, it will be evident that the laster's difficulty at the toe will be greatest if the vamp line is placed at A, while the middle line lessens the difficulty at the toe but increases it at the joints. By many pattern designers the laster's difficulties are ignored in deference to what is considered a more important factor in the appearance of the finished boot. "Draft" in the made-up shoe is discussed in § 327; the pattern designer should assist the laster to secure it, he therefore shortens the line from A to the counter-point and by this means ensures extra tension. When the first draft strain is put in at the toe the upper may be tight either at the top or along its bottom edge, but unless the upper is very evenly balanced it will not be equally tight at both places; *in the ideal upper the process of lasting should set up uniform tension over the whole of its surface, otherwise uniform contraction will not take place*, and without it the retaining of the forme of the last will be impossible, therefore any undue shortening of the front line is inadvisable.

67. Sometimes other considerations influence the position of the

vamp line, *e.g.* when designing straight goloshes, or golosh-shaped

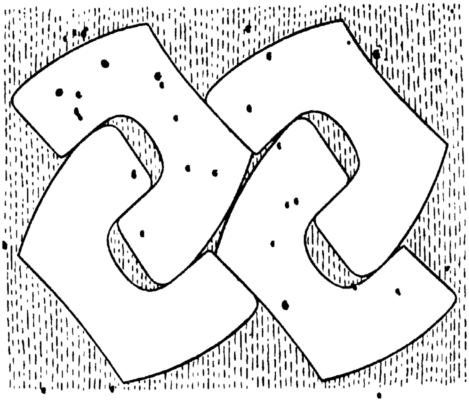


FIG. 27.

vamps for men's work, it may be desirable for economy to cut them

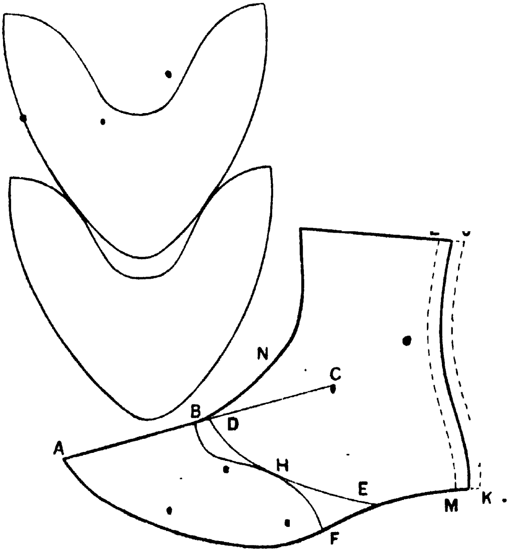


FIG. 28.

to "lock in" (fig. 27); the vamp line CD (fig. 24) in such circumstances must be parallel to the line AB, and the width of AE must be two-thirds of EF—F being on the line DC produced.

Fig. 28 illustrates the method of cutting vamps so that the toe of one fits into the opening of another. The line AB is produced to C, and the toe of the pattern brought back, so that CDHE is the same as BAF. The curve BF can then be sketched, allowing it to touch at H.

Fig. 29 illustrates a method of cutting a circular vamp by geometry; the vamp line AB is produced to H; the perpendicular distance between the widest part of the joint, D, and the line AH is trisected, and using one of the divisions as radius mark off C from B; C then is the centre of the arc BE. Let F be the point where the instep line cuts the edge of the forme, then to connect this to E find the perpendicular bisector of EF, on this will be the centre of the circle of which the arc is a part; to find the exact position draw a line from C which will determine the meeting point of the two curves BE and EF. Any shape wing can be obtained by altering the angle of CJ to AH.

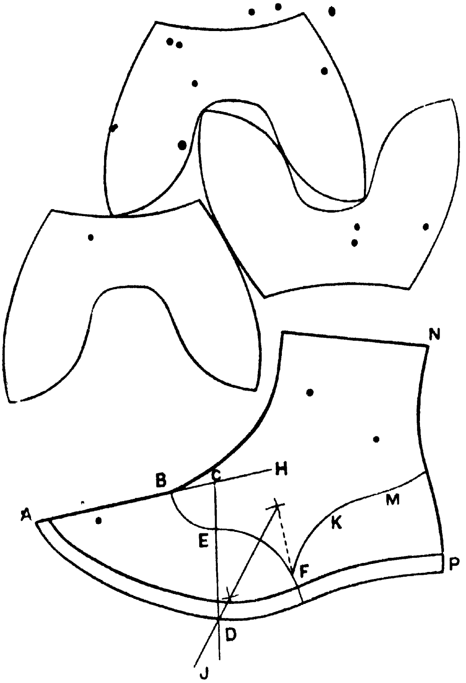


FIG. 29.

In designing the throat or front of the vamp, an attempt should be made to emphasize the character of the last; one with a square toe, for example, should have pronounced curves at H (figs. 24 and 27): the effect of the angularity being to give boldness and heaviness, consequently it is generally adopted for heavy class work, especially men's; in contrast to this the small opening which is nicely rounded harmonizes better with the narrow toe of a small fitting last (see § 84).

68. A subject which has not received sufficient attention is the importance of avoiding an angle at the junction of the vamp and quarter. A skilled laster can mould to the last almost any upper, however faulty it may be, but whether it will retain the shape of the last when the latter has been withdrawn, and whether it will be comfortable when on the foot, will to a large extent depend upon the upper itself. If the vamp is joined to the quarters with a sharp angle (made by AB and BN, fig. 28) this angle will not be lessened in the process of lasting, since the vamp seam prevents this part of the upper stretching, and the laster cannot permanently contract the fullness below the angle; true he can bring it down on the last, but this sets up considerable tension and a relative amount of contraction takes place when the last is removed, but it does not prevent the angle then reasserting itself to the detriment of the appearance, and in wear the restriction across the vamp will always cause discomfort. If the angle cannot be otherwise avoided it will be better to straighten the front by adding in a little at B.

69. The edge of the vamp may be left just as it is cut, or it may be "turned in"; the latter being the usual method when the material is thin, or not sufficiently solid to give a satisfactory result when left raw edged. Vamps cut from fabrics are either "turned in" or bound (§ 74, style 6). The allowance for turning in is usually $\frac{3}{16}$ inch.

70. The vamp outline being marked on the standard, the "quarters," "backs," or "back-quarters," may now be cut; to do this place the standard on a sheet of paper, mark around it with an awl and prick through the position of the vamp; then, removing the standard, with the aid of the vamp finish marking its position on the quarter pattern. Assuming that the stiffener has been provided for, it will only be necessary at the back to provide for the seam (§ 76) which will require $\frac{1}{12}$ inch for boxcalf; $\frac{1}{16}$ inch for glacé kid; and $\frac{3}{32}$ inch for waxed kips; the principles which determine the amount are as follows:—

(*a*) Tender material would break out with too meagre an allowance, hence the more nature the fibre has the smaller will be the amount required.

(*b*) Stout or harsh leather will require larger closing thread, consequently a larger needle; and the allowance must increase correspondingly.

71. The amount which must be allowed as a lap for the vamp will vary between $\frac{1}{4}$ inch and $\frac{1}{2}$ inch, being determined by the following considerations:—

(*a*) *The thickness of the leather in the quarters.* To reduce the unevenness caused by the seam, the edge of the vamp should be skived, as also the edge of the quarter, and the unevenness can then be reduced in proportion to the width of the scarf, but to produce uniform results stout leather will require a wider scarf than lighter material, and hence a larger lap.

(*b*) Very light and soft leather may only have one row of stitching on the vamp and only a sufficient lap would then be necessary to ensure a level surface for the feeding device during vamping; stout leathers, however, may have three rows, and the third row may not be close to the others, under such circumstances the lap allowance must be increased.

(*c*) The difficulties of the machinist must not be ignored, since where the lap is not sufficient for the pressure foot to have a level bearing satisfactory work is almost impossible.

(*d*) When the margin of the vamp is punched, a row of machining being beyond the punching, then for this also provision must be made.

72. The top edge of the quarter may be cut straight, or to any fancy design. If the leather is sufficiently stout and firm that it can be left raw-edge, the design may be varied without much additional expense; but when the edge is turned in its shape may depend on the machine with which this operation is to be performed (§ 169), but whatever method is used simplicity of design tends to minimize the expense both of cutting and closing: $\frac{3}{16}$ inch should be allowed for folding. The top of the boot may be bagged (§ 74), in which case if it is curved $\frac{1}{16}$ inch will be required, but if it is cut straight, as it usually is, then the allowance will depend upon the depth which the fold is intended to show inside.

The front of the quarter will be cut to the standard unless it is "bagged," or "folded," in either case the allowance would be as already given.

73. When "paste fitting" was the usual method in upper machining, the cutting of the linings was considered unimportant, since the fitter corrected any defects, provided there was sufficient material. With modern methods, however, greater accuracy is necessary to economize both material and labour.

The lining pattern is cut from the "standard pattern," which should be marked as to whether provision has been made for the stiffener, since if this has been added it must now be deducted because the stiffener comes between the lining and the outsides. The lining should not be as large as the outsides, therefore for $\frac{1}{4}$ inch fabric seam only $\frac{3}{16}$ inch should be allowed at the top (N, fig. 29), and graduated to $\frac{3}{32}$ inch at the bottom; this would ensure sufficient tension to prevent "full linings". From where the quarter terminates (B, fig. 29) to the end of the toe a fabric closing allowance will be necessary, but it is not unusual first to pivot the pattern at B, until at the toe (A) it is $\frac{1}{8}$ inch lower than the vamp line; the necessary alteration being made at the bottom outline; the effect is to secure a smaller fitting lining in the forepart.

Cotton and linen fabrics are generally used for the linings of boots for women and children; they are usually supported at the edges where the eyelets will be by a leather facing, the width being regulated by the size eyelet to be used and the style of finishing the edge. The size of the lining may be reduced so that the facing only has a lap of ¼ inch. At the top of the boot the lining may be finished off with either a cotton, silk, or leather topband; the last should be the entire width of the top of the leg and be attached to the lining with a lap similar to the facing. When either silk, or cotton topbands are used the leather facing should be continued to the top for support; the lining also being stronger than the silk, should be cut the full height of the boot. For the methods of treating edges see § 74.

The allowance for the back seam of the linings will depend upon the style adopted; many of these are described in § 75: the ordinary seam allowance is ¼ inch, but this may be reduced if a tape is put to strengthen it; with the lapped seam the allowance must be equal to half the amount of the finished lap; a wide lap cannot be recommended, because the back does not then sit so well, the reason being that the edge JK, fig. 28, would be machined at LM although the line JK is so much shorter.

CHAPTER VIII.

METHODS IN WHICH EDGES MAY BE TREATED.

74. THE edges of boots or shoes may be finished in either of the following styles.—

(1) The outsides left raw edge, the lining (if of leather) being raw edge also, a piping being sometimes inserted.

(2) The outsides left raw edge, the lining being turned in.

(3) The outsides turned in, the lining being raw edge (if of leather).

(4) The edges "bagged," *i.e.* the face of the lining is put to the face of the outsides, the edges are then machined round, after which the two pieces are opened out and another row of machining put round the edge, thus by keeping the fold flat it receives a finished appearance.

(5) The edges may be bound with either leather, leatherette, or galoon, the material being bent in the form of a letter U; one edge would be on the outside and the other inside, but both edges are kept down by a single row of machining.

(6) A binding material such as leather, galoon or velvet may be closed to the edge of the cover and then the loose flap turned back; in this style the face of the binding material would be laid on the face of the cover for the operation of machining it to the quarter; the flap which is turned over on the lining would be held down with another row of machining.

(7) The previous method may be varied by putting the turned-back flap between the leather lining or facing and the outsides.

75. *Styles in which linings are joined at the back seam.*

(1) Closed, then opened out and rubbed down to make them lie flat.

(2) The same as (1) only strengthened with a tape put on the side which comes next to the foot. Sometimes a leather backstrap is used instead of a tape.

(3) A lapped seam strengthened with a tape which comes next to the foot (see fig. 30). C and E represent the two linings which are lapped at D, AB is the tape and F, G the two rows of stitching, both linings being caught at F but only one at G.

(4) In fig. 31, H and J represent the two linings which are lapped at P, KL is the tape and M, N and O the three rows of machining, only the centre row passes through both linings; only $\frac{1}{12}$ inch lap is required.

(5) In fig. 32 Q and R represent the linings, R being folded at V; ST is the tape which in this style does not come next to the foot; V W are the two rows of machining, the space between them being about $\frac{3}{20}$ inch.

76. *Styles in which the back seam can be finished.*

(1) Closed, then opened and rubbed down; only suitable for light flexible leathers.

(2) As (1) with a tape at the back and a row of stitching on either side as in fig. 33; Z being the tape and XY the two rows of stitching; this style is used when the leather is too harsh for the previous method; it also strengthens the seam as the tape takes part of the strain which otherwise would be borne only by the row of closing; the stitching is often added for ornamentation.

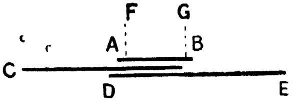


Fig. 30.

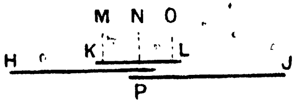


Fig. 31.

(3) The closing being done with the flesh sides of the leather put together, the seam is therefore raised on the outside and must be covered with an outside leather backstrap (see § 189).

(4) Machined edge to edge with cross-stitch machine, and finished with an outside backstrap; this is an excellent method for stout leathers.

(5) Closed as No. 1, a thin piece of leather being placed between the two backs; when opened out this is trimmed off with a welt plough, then damped and "set" with a welt iron; this method is used for stout or harsh leathers which when opened out as in No. 1 would expose the stitching, the latter being now hidden and protected by the welting.

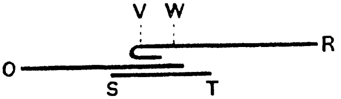


Fig. 32.

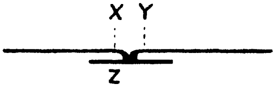


Fig. 33.

(6) One edge lapped over the other; useful for stout or harsh leather, also for economy, since only one operation is necessary if a twin needle machine is used.

77. Three details are important when designing the Derby pattern.

(1) The vamp must not be so deep that it is difficult to put the boot on the foot.

(2) The tabs must not come so far forward that they cause discomfort when the foot is flexed.

(3) The seam should not come on the prominence of the fifth metatarsal, the foot often being very tender at this place.

If the end of the tab coincides with the joint line it should be satisfactory, but it may not extend beyond the instep position—as in a

Blucher; fashion decides its width, its shape, and its position; the first varies with the material and character, as stout material requires a wider tab and the effect is in harmony with strength. It may be four, five or six twelfths of the width of that part of the pattern.

The cutting of the vamp is more important than that of the quarters, and the first consideration should be, not the difficulties of the laster, but the appearance and comfort of the finished boot, for these will not be satisfactory if the vamp joins the quarters at a sharp angle at B, fig. 34; therefore if on account of the shape of the last this angle cannot otherwise be avoided, then the vamp should be "blocked" or "crimped,"

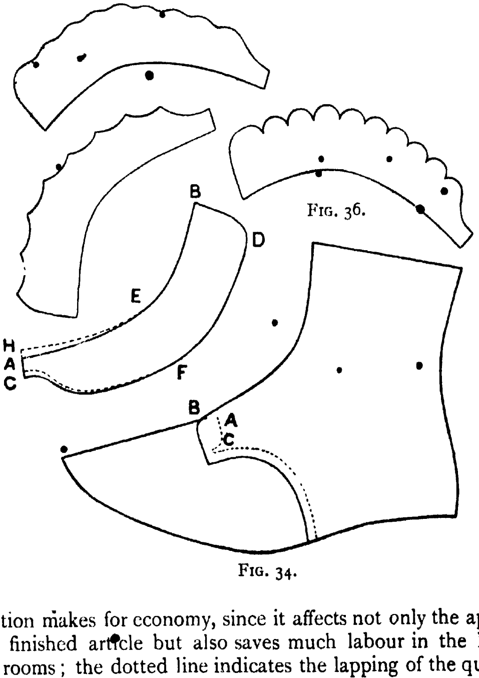


FIG. 38.

FIG. 37

FIG. 36.

FIG. 35.

FIG. 34.

which operation makes for economy, since it affects not only the appearance of the finished article but also saves much labour in the lasting and treeing rooms; the dotted line indicates the lapping of the quarters on the vamp, the allowance being as in § 71.

The tongue may be cut in any of the following ways:—

(1) Similar in shape to the tongue of an ordinary Balmoral.

(2) Full bellows, or water-tight tongue to the top of the leg.

(3) Half water-tight tongue; this is only attached to the side of the quarter up to a point just beyond the instep; it may be put in just as it is cut from the flat material or it may be previously blocked.

(4) Sometimes the tongue is cut with a seam down its centre, the

seam being covered and strengthened with a neat strap; material that is small in size can often be utilized in this way.

The tongue is attached to the vamp by one or two rows of stitching, being either laid on top or underneath the vamp; the latter is considered the neater way, but as it is necessary to slit the tongue to fit it into the corner C, fig. 34, it cannot be considered quite as satisfactory as the other method in which slitting is unnecessary.

If the tongue is cut with a seam down its centre the curve at the throat should be less than that of the standard pattern, otherwise it will be too full at its edges. At G, fig. 54, the tongue should stand back about $\frac{3}{8}$ inch.

For cutting the half water-tight tongue the desired shape should be sketched on the standard as in fig. 54; the folded edge of a piece of paper being then placed underneath the pattern as at AB, the line CD can be pricked through also as far as E; the pattern being now rotated about B the top is turned until more of the outline between B and G coincides with the folded edge of the paper enabling more of the line from E to F to be pricked through; this method must be continued until G is reached; at CD the paper is folded and HJ marked; the amount which will be required will depend upon the width of the facing since the row of machining on this must catch the edge of the tongue; in fig. 53 the folds are shown by dotted lines.

The linings are generally cut in sections, since the vamp and quarter cannot easily be cut in one piece; when the quarters are of leather, the vamp and vamp lining may be cut the same size; in machining, the vamp lining would be fitted between the quarter and quarter lining. Leather vamp linings may be joined down the centre, but fabric would not.

78. With button boots it is usual to make the opening of the front or "cue" of the vamp a little wider than for a lace boot, otherwise it would look cramped where the button-piece ended; the inside quarter pattern must have a seam allowed (§ 70) for attaching the button-piece, but the outside quarter may with advantage be cut smaller than the standard pattern, the amount being graduated from nothing at the bottom to $\frac{5}{16}$ inch at the top.

The button piece must not be cut the same shape as the inside quarter, because it is so liable to stretch both in machining and in making, that instead of fitting close to the side of the leg its edge would stand off in flutes; it is therefore desirable that the outside edge be shortened, and since the difference between the length of the two edges AB and CD, fig. 35, will be in proportion to the sharpness of the angle at E, it will follow that if the button piece is made with less curve, the two lines will be nearer alike in length and the desired result be obtained; using the inside quarter pattern on which the seam has been allowed, the front line from E to B can be marked, then pivoting the pattern at E, A can be brought about $\frac{3}{8}$ inch below H. At EF and BD the pattern must be wide enough that the button-holes are not too near its edge or too close to the seam; apart from this the width is decided by taste and fashion.

The line CFD may be varied in shape as in figs. 35, 36, 37, 38; the design being selected according to the character of the boot and the method of machining. For men's work fig. 35 is always used; its edge can be finished in styles (1), (2), (3) or (4), § 74. Fig. 36 may be finished in styles (1), (2), (3), or piped; fig. 37 in styles (1), (2) or (3); fig. 38 is generally bagged. The allowance at the edge CFDB must be decided by the method selected. Button-piece linings are often cut in two sections, as this is economical and not detrimental either to appearance or utility; at the edge CFDB the allowance required will depend upon the style of finish, but the amount necessary at AEB must be decided by the method of attaching the button-piece lining to the lining of the boot (§ 188).

79. The designing of the French or waved back golosh may be left almost entirely to taste, although on two points certain principles should not be ignored. If at the back the golosh is too low, the seam will come at the part where the back curve is most convex, thereby adversely affecting the appearance, but the golosh being too high causes the seam to come just where the back changes its shape with the movements of the foot, and this strain on the seam soon weakens it; $\frac{1}{4}$ inch above the counter-point gives satisfactory results. The height of the golosh at the side, and the relation of its curves to those of the vamp need studying for appearance; where the golosh meets the vamp the curves FE and FK, fig. 29, should be symmetrical about the line FJ which is perpendicular to the pitch line, and if the vamp has a long wing with a flatness at E, the golosh having a similar flatness at M, a line drawn from one flat place to the other should be parallel to the pitch line.

Whole goloshes cut to inter-lock must not be deeper at the back than AE, fig. 24 (see § 67).

CHAPTER IX.

SHOE PATTERNS.

80. In the construction of shoe standards the following principles are important:—

(*a*) The uppers should fit as closely as possible around the top.

(*b*) Provision should be made for probable stretch during manufacture.

The last-maker helps to make the shoe fit the foot by thinning the quarters of the last and increasing the curve of the back, thus shortening the line CF, fig. 11. The pattern-cutter with a similar design after cutting the mean forme in the usual way, reduces its size at F, fig. 11, thus further shortening the line CF; a greater tension is therefore set up around the top, the object being that in the process of lasting more of the stretch in this part shall be taken out. If however the pattern-cutter sets up too much tension, the contraction will be so great when the last is removed that the upper will curl inwards and the foot will not be able to fit back into the heel of the shoe at H; another very serious result being that the strain considerably weakens the back seam.

81. The design of the top of the shoe cannot be left entirely to taste, since its height at the front is limited by the alteration in the shape of the foot at the throat, when it is flexed on the leg. If the position of the heel line is located by the rules already given, then a line drawn at 5° less will, by crossing the outline of the forme, indicate the limit in height for the front of the shoe. The height at the side is governed by the height and position of the outer ankle, the lowest part of which would be at that part of the top of the shoe which is cut by the perpendicular erected from the centre of the heel line, as CD, fig. 26; this will not always be at the same distance from B, since the amount decreases as the heel is raised and is greatest when there is no heel. The height of the finished shoe at J should not be more than $2\frac{1}{8}$ inches for women's and $2\frac{1}{4}$ inches for men's (measured perpendicularly to GH), otherwise the ankle will be chafed by the sides of the shoe which in turn will be considerably stretched in the quarters by the protruding outer ankle.

At the back the depth is affected by the alteration in shape of the back of the leg when the foot is either extended or flexed in the action of walking. The effect of the shoe being too deep will depend upon the flexibility of the upper; if it is stiff at the back the shoe will be forced off the foot with the contraction of the calf muscle, and the friction set up will adversely affect the hose; but if the material is soft the back of the shoe will yield and a crease will be formed; ½ inch above the counter-point should be ample for men's and women's, although in many instances ⅜ inch is allowed.

82. The hollowness of the curve at M, fig. 26, is entirely a question of taste since it is not affected by the movements of the foot, but the shape at K and L may depend upon the method of machining. The top of the shoe may be finished in either of the following ways:—

(1) When a leather quarter-lining is used, the covers or outsides being raw edge may be fastened to the lining with a row of machining around the edge which would then be trimmed square; a piping, however, is sometimes inserted.

(2) The covers may be raw edge, the lining—either linen or leather—having its edge folded, or turned in.

(3) The lining—when leather—may be raw edge, and the cover folded.

(4) The top may be bagged, using either a fabric or leather lining, in which case the shape of the top would be designed as at L, fig. 26; if the curve at M is flattened, less difficulty will be experienced in bagging.

(5) The lining being either leather or fabric, the top may be bagged from K around B to K, the front from K to the vamp being folded. The front in this instance is always designed as at K, a leather facing or leather lining being necessary.

(6) The tops of canvas shoes and ward shoes are often bound with galoon which the machine evenly shapes to the form of a U, the two edges of which are kept down with a single row of machining.

(7) A binding material such as leather, galoon, velvet or fur may be closed to the edge of the cover and then the loose flap turned back as with a folded edge; in this case the face of the binding material would be laid on the face of the cover for the operation of machining it to the quarter. The edge of the flap which is turned over may afterwards be kept in position by one of the following methods:—

(*a*) By "felling" it down to the quarter-lining.

(*b*) By placing around the edge another row of machining which will pass through the edge of the turned-back flap.

(*c*) When a leather lining is used, the edge of the flap may be turned in between the lining and the cover, the result being a lighter and neater appearance.

(8) Sometimes the tops of canvas shoes are folded twice, this is known as "rolling". The necessary allowances for the top of the quarter pattern will be as in § 73.

83. It is usual to line the quarters of shoes with leather; this is partly for appearance, since a delicately tinted lining gives to the shoe an effect which cannot otherwise be obtained, but even if this is ignored the amount of friction which usually takes place at the heel makes a good heel lining indispensable. The linings are generally joined at the

back—although it is admitted that to have two closed seams together is very undesirable, especially considering the great strain at this place. Sometimes linings are cut so that a seam at the back is avoided; this, however, cannot always be recommended, since if the lining is cut large enough to fit back at W, fig. 26, it will be too large at H, while if BH is connected with a straight line, the tension set up at W during the process of lasting will be followed by relative contraction when the last is withdrawn; this causes the lining to spring away from the stiffener unless a very good adhesive has been used and the shoe allowed to remain on the last until the lining is securely fixed; linings should not be cut in this way when there is much curvature at the back of the last.

If the lining is of leather only a closing seam will be required at the back, but the lining around the top must be less than the outsides by about $\frac{1}{12}$ inch, according to the nature of the lining and of the outsides, while at the bottom of the back it should be $\frac{1}{8}$ inch smaller, otherwise it will be difficult to ensure clear fitting linings. A similar method should be adopted with fabrics.

The vamps are generally lined with a fabric. It is important that the leather quarter lining should make a separate leather facing unnecessary, but the quarter lining should not be joined to the vamp lining where the quarter is joined to the vamp, since the two seams coming at the same place may cause discomfort; in fig. 43 the dotted line AB is the edge of the quarter, the solid line indicates the position of the vamp, and CD the edge of the leather quarter lining. When fabrics are used for vamp linings it is usual to avoid a seam down the front, but if the leather quarter lining is cut much shorter than the outsides, the vamp lining would have to be joined to the quarter lining before attaching the latter to the outsides, in which circumstance a seam down the centre of the vamp could not easily be avoided.

The warp threads should be in the direction of the length of the shoe; sometimes, however, they are cut on the cross or "bias"—with the threads running diagonally; the only argument which can be advanced in favour of this is that the laster can with greater ease bring the material to the last; this must be conceded, but the disadvantages outweigh this, since it is so well known that material cut in this way will not retain its shape but yields in the direction of greatest strain, therefore in wear such boots would quickly lose their shape.

84. The successful cutting of "Court" and "bar" shoes is not difficult if the lasts are correct, but if they are defective satisfactory results cannot reasonably be expected. For the Court shoe to cling to the foot the bottom of the last from the joint to the heel must be similar in shape to the corresponding part of the foot when it is supporting the weight of the body (§ 24); should it be otherwise the foot will quickly make the shoe this shape and the result will be that its sides will gape—*i.e.*, stand away from the foot.

Writers give different methods for designing the Court shoe, but the reason is not far to seek, since lasts differ so much that a system which produces excellent results under one set of conditions may be unsatisfactory when the conditions are varied. One method is shown in fig. 40: AB is the folded edge of the paper; AC the depth of the front—generally ⅓ of the last length; CD (perpendicular to AB) equals half the width of the last from the edge on one side to the edge on the other; the position of the length of the pattern is marked on AB as at E; having trisected CD, from its first division—F—draw a line to E; let FH bisect the angle CFE; where FH cuts CE will be the centre of the arc for the front. If it is desired to make the front more angular in shape the centre may be taken nearer J, fig. 39, and a smaller radius used.

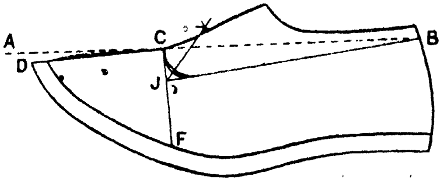


FIG. 39.

Fig. 39 shows the Court shoe cut to a last where the result obtained by the previous method would not be so satisfactory since the toe of the pattern if raised to the line AB would cause such an excess of material around the feather that the laster's work would be made very difficult. Having cut the forme and drawn the lines CD and CF, find J by the previous method and connect it with B, the desired height of the shoe at the back. Economy cannot be entirely ignored, and since many Court shape shoes are cut from fabrics the effect of both methods should be considered. The pattern produced as in fig. 40 causes the minimum of waste as is seen by fig. 42; but fig. 39 causes the opening of the quarters at AB, fig. 42, to be greater, the waste being thereby increased. The pattern is often cut with a seam at the side, in which case the tension at the top can be effectively increased by cutting away $\frac{1}{16}$ inch at CD, fig. 41. When the quarters are lined with leather, it should extend as far forward as the opening at the front, otherwise it would not cover enough of the inside of the shoe to ensure a pleasing appearance.

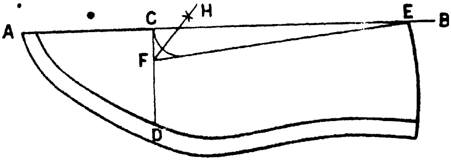


FIG. 40.

85. The Albert, or tab slipper is a development of the Court shoe. To obtain satisfactory results the forme should first be cut; this has not

always been done, but the great improvement in slipper lasts in recent years necessitates an alteration in the method of cutting the pattern.

Using the forme, now mark the height of the shoe at the back (§ 81), this gives point A, fig. 48 ; from A with the heel measure as radius mark the point B where it cuts the edge of the forme and draw the line CBD ; let E be the toe of the forme, then one-fourth of EB marked off above B will indicate the depth of the tab ; let BF be perpendicular to CD, and trisected, then from the first division the line HA is drawn, the shape at HLD can be sketched in and from D the line JK can be drawn perpendicular to CD ; if the seam is made as in fig. 41 it will help considerably to make the top of the shoe fit closely. Unless a stiffener allowance is added a little reduction should be made at A otherwise the shoe will be too full around the top.

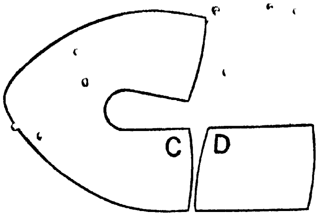


FIG. 41.

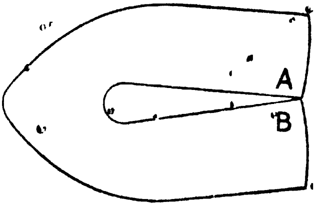


FIG. 42.

The only way to machine this shape slipper is to bind it, unless the uppers are both light and soft—some felts for example—which may be bagged.

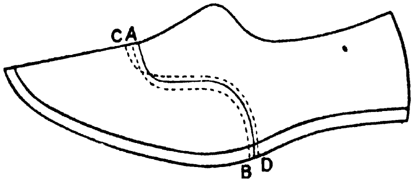


FIG. 43.

As the line CD is so much above the forme at M a corresponding reduction may be made at N. The principle involved can often be applied.

86. The cutting of bar shoes affords the pattern cutter an excellent opportunity for the development of original designs ; most of the guiding principles have already been referred to, for example :—

(*a*) The designing of the vamp.
(*b*) The height of the shoe at the back (§ 81).
(*c*) The height under the ankle (§ 81).
(*d*) The height at the throat (§ 81).

Between the vamp and the throat there may be one bar, or several, but the principles to be observed are the same; the direction of the bar should be that of the instep line, the paper being folded over at the outline of the forme; with the intention of tightening the shoe, either at the front or around the quarters, the angle at which the bars are cut may be altered, but any deviation from the angle named will only result in tightening one at the expense of the other.

The position for the buttons in a bar shoe is left to fashion and to the judgment of the pattern cutter, there are no inflexible rules which must be observed, hence the great variety of design; for a guide, however, draw a perpendicular to the vamp line at the position decided on for its depth; the perpendicular (without the lasting allowance) is trisected as for a Court shoe, and a line drawn to the top of the back as AB, fig. 52; the shoe may be designed with the buttons on this line. The front can be obtained as in fig. 39. If it is desired for economy to reduce the length of the bars, a line for the buttons may be obtained by trisecting the instep line and connecting the first division with point A, fig. 52.

There are many ways by which the quarters may be attached to the vamps. They may be laid on the vamp, in which case they are generally joined at the centre of the vamp, the seam being covered with an ornament. The edge of the quarter which overlaps the vamp may be left raw-edge, or be turned in and may be cut plain or with fancy design.

If the vamp is laid on the quarters, these may be joined at the centre as already described, or the vamp may lap over the quarters as shown in fig. 52, the edge being either straight or of fancy design; preferably at C the angle should be nearly, if not quite, square.

87. Three things are interdependent in bar shoes :—

(*a*) The character of the particular design.

(*b*) The material to be used for the lining.

(*c*) The method of machining.

Bound edges. With a few exceptions any design, with any material in the lining, can be machined with bound edges, but it is advisable that leather should be used for the lining where the button-holes will be.

Bagging. Many fancy designs, with any material in the lining, can be bagged, provided that it is possible at all places to add the necessary allowance for bagging, and to turn them satisfactorily; but where the button-holes are to be it is advisable that the lining should be supported with leather.

Beading. The outside may be beaded if there is room to add the necessary allowance, under which circumstances a leather lining would be used for at least that part of the lining next to the beaded edge.

Beaded linings. The linings may be turned in and the outsides be raw-edge, provided that it is possible to add the necessary allowance; either leather or fabric may then be used.

Raw-edge. When the design is such that it is not possible to add the necessary allowance either for turning in, or bagging, then (apart from binding) the only method of machining possible is raw-edge, and a leather lining will be necessary but a piping may be inserted.

188. Whole-cut shoes can be made very economically from fabrics, but the method of machining must be decided before attempting the pattern; it being customary to use a fabric for the lining, the top of the shoe from A around B to A, fig. 44, must either be bagged or bound (for machining see § 192). If it is to be the former there must be an allowance of about $\frac{1}{10}$ inch according to the material. To produce a pattern like fig. 45 cut the shoe standard to the desired shape at DAB, fig. 44; now draw a line CB and putting the back of the pattern below it an amount equal to the intended machining allowance, let the front cross the line where the facing is to be, as at D; the part of the pattern BGE can now be marked around, then rotating the pattern about D bring the toe to the line CB and finish tracing the forepart. If the last is suitable for this style of shoe it ought not to be necessary to rotate the pattern about D. Fabrics often require a stiffener allowance. By folding the paper at CB, the pattern as fig. 45 can be cut out; the facing can now be designed, it must come below the dotted line DA, fig. 44, far enough that it has a firm hold; both facings are cut in one piece as shown at fig. 46, and since the lining does not come above the line DA, fig. 44, it will be necessary to use a leather inside facing which must be at least $\frac{1}{8}$ inch larger than the outside facing to ensure it being caught when the top facing is

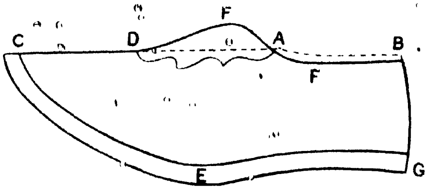


Fig. 44.

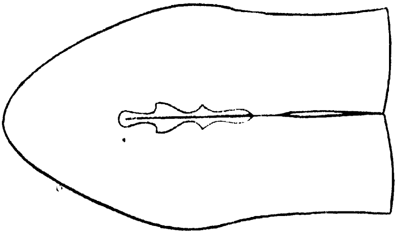


Fig. 45.

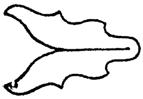


Fig. 46.

machined. If the shoe is of leather, the facing may be put underneath, in which case a plain or fancy design may be cut as shown fig. 45; when the shoe is cut from glacé kid this part is often beaded.

Should the facings be put underneath they need not be cut whole, since there will not be the probability of splitting the whole-cut front.

CHAPTER X.

BOTTOMING PATTERNS.

89. THE pattern-cutter is generally required to cut patterns for the different pieces used in bottoming the boots; this is generally considered less difficult than designing the patterns for the uppers, because all the pieces (except the "stiffeners" and insoles) are finally shaped by the finisher after the boots are made. The uses of the stiffener are given in § 265, also the considerations as to its height and length, but the method of cutting it is important, for the same rules do not always apply since the shape is affected by the method of lasting. In wear the edge of the stiffener is very liable to stretch, especially if the leather is inferior; with the object of reducing this tendency and to cause the stiffener to fit close to the sides of the last, a good workman when lasting by hand (if using a leather stiffener) before tacking down its corners gives them a pull in the direction of the toe and then down towards the insole; the result being that the shape of the stiffener is changed from that of the solid line to the dotted line AB, fig. 47; but when work is lasted by, or in conjunction with, machinery the pulling up of the corners of the stiffener is often omitted, and provision for it must not be made, hence they should be cut as the dotted line. In moulding stiffeners by machine the first grip of the moulds is at the part which projects most, as at H, fig. 11, and instead of the top edge being strained, as in hand lasting, the fullness is now compressed or with some materials apparently crimped in; consequently if the pattern is sprung at the corners, when moulded it will not sufficiently lap over the insole for satisfactory results. In Court shoe lasts where the waist is so straight from E to D, fig. 11, it may be necessary to cut the bottom line as in CD, fig. 47.

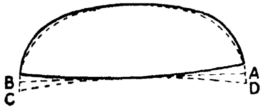


FIG. 47.

90. Insoles should be cut to the shape of the last around the forepart and the seat, also at the waist if the shape is defined on the last, otherwise this part must be designed. To obtain the shape of the last select a paper that is fairly strong, yet thin and with an absorbent surface; this should be shaped a little larger than the last to which it must afterwards be attached by drawing pins or tingles, using either leather or paper washers to reduce the probability of the paper being

torn. It is generally considered advisable to avoid any twisting of the paper, although in lasts that are hollowed very much under the instep at the inside waist, but not in a similar manner at the outside, the paper should be first placed in position at the waist and then smoothed towards the ends of the last—toe and heel; this is not always done, but should be, because after having been correctly moulded the insole, even though of harsh material, would fit down in the waist of the last much better and thereby considerably lessen the difficulty of the laster at this place. When the paper has been fastened to the last, pass the palm of the hand carefully over its edge in such a manner that the outline is marked on the paper (there is generally enough natural grease in the hand for this); the paper can now be removed from the last and the pattern cut out and tested. When the waist has to be sketched in, it should be very carefully done, since the shape of the finished shoe so largely depends on the insole. Measured from the back, the seat position is at $\frac{1}{6}$ of the standard length of the last and should be the widest part of the heel, the length of which should be $\frac{1}{4}$ of the standard last length; the most hollow part of the waist on either side should be midway

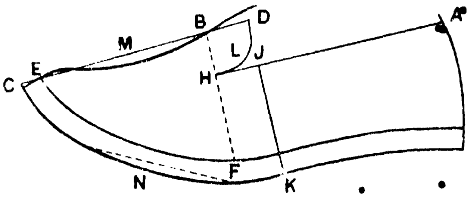


FIG. 48.

between the corner of the heel and the joint. No scale can be given for the relative hollowness of the outside and inside waist, since although in feet the shape of the outside probably varies but little yet the arch at the inside varies considerably and consequently so does the hollowness of the insole; but as the arch of the foot becomes more and more defective the person will require a lower heel, which results in a larger proportion of the weight of the body being sustained by the back part of the foot, hence the waist of the insole should then be broader.

The shape of the toe of the last and the width of the waist should be in harmony; we generally associate a narrow waist with a narrow toe and a wider waist with a broad toe, it would not however be contrary to any fundamental principles if it were otherwise, although possibly not in keeping with what the eye has been trained to approve. It is different with the influence of the class of work, since light substance work may be made with either a broad or narrow waist, but heavy goods must not be made with a narrow waist, for it would not be sufficiently strong to keep the boot in its shape.

There are also certain features which are characteristic of men's work as distinct from women's; the former usually has a broader toe and this calls for a different shape top-piece, wider at the back, and of heavier appearance; therefore the foundation—the shape of the heel part of the insole—should be suitable for such a heel.

In women's work the low heel is only used when conditions make it unavoidable; as a result more of the joints now assist in bearing the weight of the body; on the other hand with the same height heel in a man's last, although the outside joint would be similarly affected, yet the inside waist would not, since the low heel in this case is not the result of foot weakness, but of fashion; the result of the foregoing is that difference in effect which enables one—apart altogether from the length—to distinguish so easily between typically women's, and typically men's lasts (figs. 49 and 50).

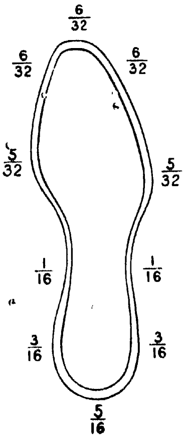


FIG. 49.

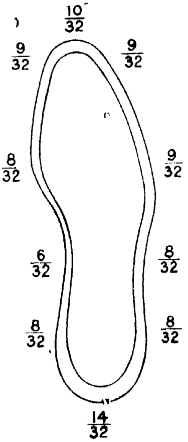


FIG. 50.

91. In the designing of sole-shapes for women's Blake-sewn work, provision must be made as follows:—

At the sides of the forepart: (*a*) for the total thickness of the upper; (*b*) to provide for reduction in width caused by channel closing, edge trimming and edge setting;

(*c*) Width of welt desired.

At the toe extra provision must be made for the additional thickness of the toe-cap and toe-puff.

At the waist it is not necessary to consider the substance of the upper, since it is not usual to show a welt in the waist, but if stout shanks are used they have a tendency to make the sole narrower and this should be taken into account.

At the side of the heel, provision must be made for the thickness of the stoutest stiffener that will be used and for the substance of the upper; there will be some reduction in width during finishing but there is no welt to be provided for.

At the back of the heel, more will be required than at its sides, because of the seam, and when a middle sole is used this necessitates a little extra length in the sole.

Allowances which have been found satisfactory are indicated in figs. 49 and 50, the latter being stitched to heel.

In *men's work* rules similar to those for women's work hold good for Blake sewn, rivet, or screw attachments, except that there is usually less difference between the width of the forepart and the waist.

There should be a definite attempt to develop artistic shapes in sole patterns; the curves should be tastefully designed and in each sole shape all its curves should harmonize; the importance of this may soon be demonstrated by taking a sole shape that appears faultless; now slightly alter one of its curves, and the whole shape will appear as a discord if the altered curve does not harmonize with the others.

The distinctive character of men's and women's patterns should also be maintained; even those outside the industry on looking at figs. 49 and 50 could easily recognize both types; we sometimes see work which is praiseworthy in many of its details, yet spoilt by the design of its sole shape—a fault which is more conspicuous in men's than women's work.

The curves of ladies' work should be refined, but in men's work pronounced. The design of the former should suggest lightness, but the latter solidity. The one should convey the impression of daintiness, the other fitness for service, the straightness of the outside waist always being more pronounced.

When boots have some portion of the edges stitched, whether it be only the foreparts or also one or both sides of the waist, then the necessary allowance must be added; to give figures for this would be useless, since the amounts which have proved sufficient for satisfactory results under one set of conditions may not be so when any of the conditions are changed.

With sewrounds the methods of making are so many and so much depends upon the width of the channel, in addition to which the styles of finishing the edge vary so much that experiment with these may also be unavoidable.

When designing sole shapes there are some general principles which should not be overlooked.

Utility is most important since the manufacture of goods lacking in such an essential feature cannot be considered satisfactory; the welt should be wide enough on strong work to afford a sufficient protection for the upper, and the waist should not be so narrow that the efficiency of the boot is impaired. It is generally possible to combine *appearance and utility*, without in any degree adversely affecting the latter, and considering the importance of the former from a selling point, there cannot be any excuse for its neglect. Business considerations require that economy shall be duly considered, especially when neither of the other two points suffer in consequence. In chapter xxiii.

the usual systems of placing sole patterns may be studied, and before finally adopting any pattern it should be tested, since often it may be improved with a view to economy, particularly at the sides of the seat, and the swell of the joints.

92. *Middle-soles.* The object of these is considered in § 270; when cutting the patterns the following details should not be overlooked.

(*a*) They should be at least $\frac{1}{32}$ inch wider than the sole pattern because it is not at all uncommon for the leather to shrink somewhat after it is cut, and should the pattern be only the exact size of the sole then the leather after shrinking would be too small to be usable, which in the smallest size may result in serious loss; besides this, the edge of the leather cut with some knives is often not quite square, and if no margin had been allowed the finisher would be obliged to reduce the size of the sole before he could make a satisfactory edge; but apart from this it is not economical to cut them the exact size of the sole, since this would necessitate such accurate attaching that the time occupied would incur a greater loss than the value of the material saved.

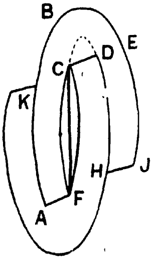


FIG. 51.

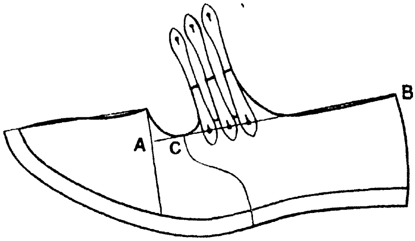


FIG. 52.

(*b*) The length of the middle-sole should be varied according to the height of heel (§ 25); it is the better plan to stand the last on the board and raise the heel to its position in the finished boot, then it would not be difficult to mark on the last how far back the forepart should extend *for that last;* when they are left too long material is wasted, and the finisher has unnecessary work.

(*c*) The angle at which the middle-sole should terminate is not uniform for all lasts, it approaches nearest to an angle of 90° to the line of muscular action (§ 16) in boots designed to carry high heels, the angle increasing as the heel is lowered. The cost of the material should be considered, for if the pattern is larger than it need be then the value of that amount is wasted.

93. Skeleton middle-soles are used in heavy work to compensate for the reduction of substance resulting from the compression of the edge by the method of attachment; fig. 51 illustrates the method of cutting. The pattern should be designed as described for an ordinary middle-sole; having marked round the desired width of the skeleton,

cut out the centre, thus obtaining the shape ABEJHDCF. Trace this pattern round on a sheet of paper, except from DE to HJ. If the edge FC is turned round so that F falls on C, the same portion as before can then be traced as at FCDH. It will be observed that AK stands away from AB, hence rotate the pattern about A until KA fits on AB; now trace the outside of the sole to complete the shape. Next replace the pattern on ABEJ and rotate it about D, fitting DH beside the already completed shape; the pair may now be finished by tracing the portion EJ and joining CF. The effect of designing the pattern as described is to economize material, since the skeleton is not as wide across as the middle-sole would be; it will be noticed that they are both for the same foot.

94. The cutting of patterns for lifts is not difficult, yet it should be very carefully done since the same patterns will be used so many times that even a very slight amount in excess of what is absolutely necessary might in one week represent a considerable sum. Heels on women's work vary so much in shape that it is advisable to have a heel built (the largest size to be used) similar in shape to the general pattern; after being finished this can be taken to pieces, since it will be a guide for the length, the width, and the shape of the back; take the largest and smallest sizes and add a working allowance of $\frac{1}{16}$ inch all around; the intermediate sizes can be obtained by the comparative method of grading, the space between the two patterns being divided by the proportional dividers or by a tool which can be constructed as follows: Draw a line of any convenient length, at one end erect a perpendicular and mark off as many *equal spaces* as there will be between the set; the tool being completed as in fig. 55; the side of this tool which has the dividing lines marked on it is placed downward and folded back at the place where it corresponds in width to the space between the two patterns, marks being made at the lines as shown in fig. 55; the illustration shows how the full set can be obtained by letting the outlines pass through these marks.

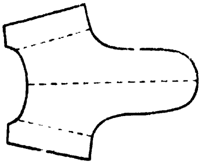


FIG. 53.

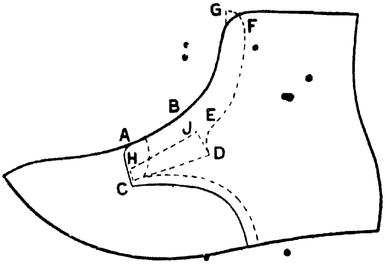


FIG. 54.

95. By the method just described any set of patterns can be produced, but it has this disadvantage that it is necessary to have two patterns

—preferably the extremes in size—before the system can be adopted; recourse is therefore had to what is known as the geometric method of grading as illustrated in fig. 56; the principle of the method is that of Euclid VI, 2 (see *post,* Appendix II, fig. 11), from which it is evident that if it is desired to describe another triangle similar in shape to ACH, but in which AC will be lengthened to AB, it will only be necessary to produce AH until it could be cut by a line drawn parallel to CH from B, as BF. The accuracy of this can be established by arithmetic since if AC equals 8 inches, and AH equals 6 inches, it being required to lengthen AC to 12 inches (AB), and AH in the same proportion; then as AC (8 inches) is to AB (12 inches) so is AH (6 inches) to AF (9 inches), as may be verified by measurement; 12 being one and a half times as great as 8, and 9 being one and a half times as great as 6; it would however be difficult to take each of the radial lines in fig. 56 and calculate it separately, although with the parallel ruler a series of patterns could be produced, since having decided on the increase at H the amount of increase on the adjacent radial line N would be determined by the method just explained (App., fig. 11); the grade at the next radial line P would then be determined from the increase on line N, the operation being repeated until the length of each line had been ascertained. The method, however, has this disadvantage, that an error in any line would result in all the subsequent measurements being inaccurate, whereas with the method known as the "radial" there is not this risk.

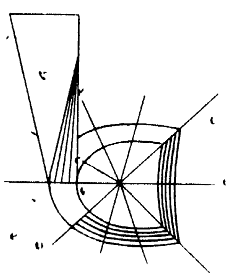


FIG. 55.

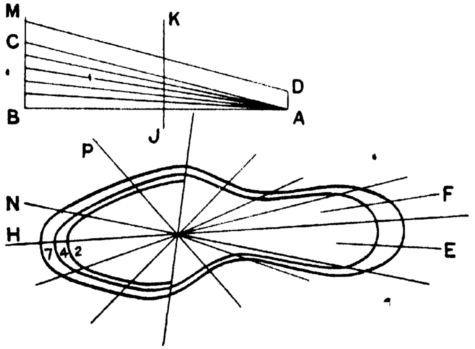


FIG. 56.

The plan adopted is to make a tool as for fig. 55, only the base line

AB, fig. 56, is now made equal to the length of the pattern and the spaces marked from B to C equal to the increase or decrease in length of the patterns in the set. If it is a set of women's insole patterns, sizes 2 to 7, then mark off 5 spaces, each being $\frac{1}{3}$ inch, since this is the difference in length between consecutive sizes; from each of the marks draw a line to A, using a fine smooth awl, since with it a finer line can be drawn and the mark made is more definite, while pencil marks quickly lose their sharpness. The tool can now be cut out as shown in fig. 56, leaving an excess as at MD to strengthen the point which otherwise would quickly wear away. Radial lines are now drawn as in fig. 56; any position may be selected for the radial centre since the result is not thereby affected, it is desirable, however, that as many of the radial lines as possible should cut the outline at a sharp angle, the position of the prick mark being then much easier to define. The radial lines should be drawn with a fine awl, but should not be continued to the centre, as in fig. 56, because so many lines converging together have a tendency to produce a blurred patch rather than a clearly defined point; lines E and F are long enough for practical work. The probability of accuracy will be in proportion to the number of radial lines used, but with practice and a well-trained eye a less number may be employed. To use the radial tool place it face downward with the end A at the radial centre and fold it back where it cuts the outline of the pattern to be graded, the end B of the paper must always be folded back on the straight edge AB, since this will ensure the paper being folded at right angles. The folded edge of the tool must now be placed on the radial line, the marks indicating the increase in size for the larger sizes and the decrease for the smaller sizes. The distance from the centre to where the line H, fig. 56, cuts the outline of the pattern, is shown on the tool by JA, the spaces along JK indicating the difference between the consecutive sizes at this part of the pattern.

This process must be repeated for each of the other radial lines.

96. For the foregoing system of grading it has been assumed that the lasts were designed to increase in size in regular proportion, that is, a woman's last size 5 is 10 inches long and may measure $2\frac{1}{2}$ inches across the tread; we find by arithmetic that if 10 inches give $2\frac{1}{2}$ inches then $10\frac{1}{3}$ inches (size 6) should give $2\frac{7}{12}$ inches for the tread width; the difference in tread width between the two sizes is $\frac{1}{12}$ inch in this instance, this being—in practice—*the difference generally made between consecutive sizes in all fittings;* therefore if the last had been size 5 youths, and the tread width 3 inches, in practice size 6 would measure $3\frac{1}{12}$ inches, whereas according to true proportion if 10 inches (size 5) has a tread width of 3 inches then size 6 being $10\frac{1}{3}$ inches should have a tread width of $3\frac{1}{10}$ inches, this, however, exceeds the amount allowed in practice by the difference between $\frac{1}{10}$ inch and $\frac{1}{12}$ inch, namely $\frac{1}{60}$ inch. It may be urged that this amount is so small that no serious evil would result if it were ignored; in a range of six sizes, however, the difference between the extreme sizes would be $\frac{1}{12}$ inch greater than it should be, and this would cause the patterns to be unworkable. Fortunately the

geometric system of grading can be adapted to overcome this difficulty, it only being necessary for grading purposes *to indicate on the pattern*

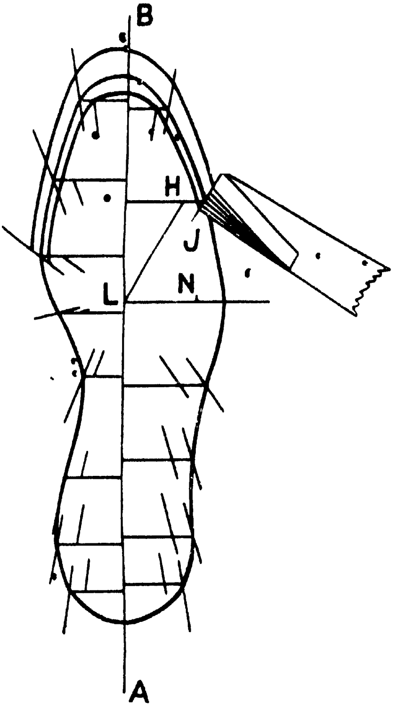


Fig. 57.

what reduction would be necessary so that its tread width would equal ¼ of the pattern's length ($\frac{1}{12}$ inch being ¼ of ⅓ inch). The method is as follows: Select the radial centre and draw a straight line through it as AB, fig. 57; now mark those parts where it is deemed advisable to apply the grade—where the contour is most pronounced in shape; perpendiculars are then drawn from AB to these points, as in fig. 57. A tool is now made the base of which CD, fig. 58, must equal the width of the pattern, its height DE being ¼ the length of the pattern. It now follows that the part of the pattern which in width equals CD, fig. 58, must be reduced to DE, and that.

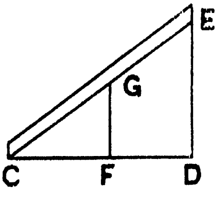


Fig. 58.

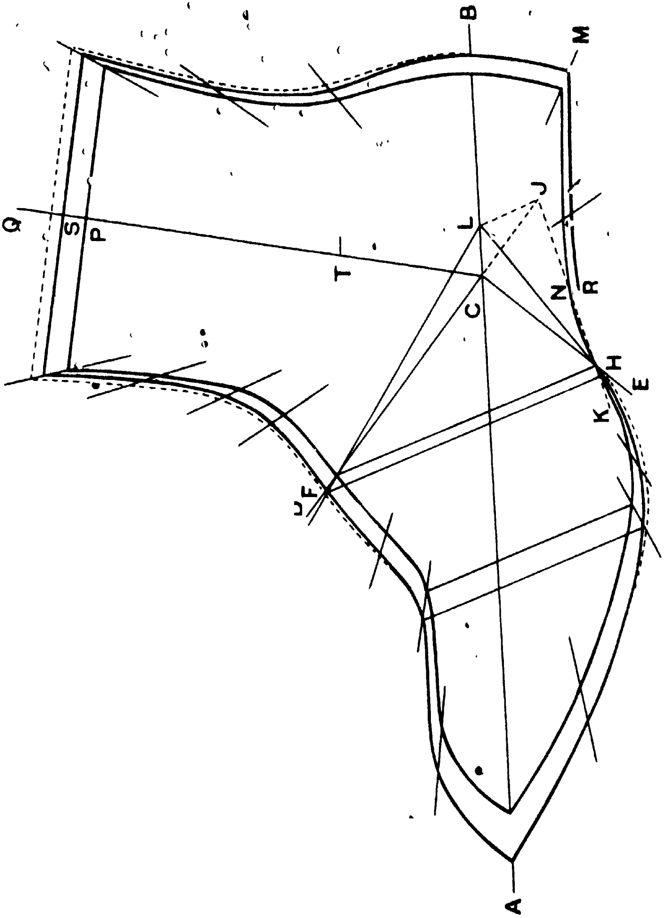
if the width of the pattern at any place is measured from C towards D —as at F—a line drawn perpendicular to CD from F will indicate the amount to which the line on the pattern must be reduced; hence now measure either of the perpendiculars from AB, fig. 57, to the outline, fold the tool and mark off the distance FG from the line AB as at N; the other perpendiculars must be similarly reduced.

Instead of using the tool just described, proportional dividers may be used, moving the pivot until the distance between the points at one end equals the width of the tread, and between the other points ¼ the length of the pattern; measuring the height of the perpendicular with one end, the other points will indicate the amount to which the line must be reduced. Lines are now drawn from the radial centre to the marks just made, as LH, after which short lines must be drawn from the perpendiculars, *and parallel to the radial lines, as JK in fig.* 57. The grading tool is made as in § 95, then placed at the radial centre and *folded at the mark on the perpendicular as at H*, the distances being afterwards set off at the end of the perpendicular, as on the line JK; the process being repeated for each of the radial lines. In practice the edge of the parallel ruler may be placed so that it touches at L and H, no line need be drawn, but keeping it in this position it may be opened until it touches the outline of the pattern when the line JK would be drawn.

97. The "stencil" being completed take another sheet of paper and with a fine awl prick through the holes of the size next larger to the one being graded from; now place the standard on this sheet of paper so that it rests at the mark made for the position of the toe and make a short cut; the pattern can now be moved so that it acts as a guide in cutting from one prick mark to another, until the pattern is completed.

98. The methods of grading upper patterns are similar to those described for bottoming patterns, although the comparative method is now seldom employed. When the joint measure of the pattern does not exceed one-fourth of the length of the pattern the simple radial method may be used, but in other circumstances it must be modified or "adapted" as follows:—

First draw a line cutting through the end of the toe and the back of the pattern as AB, fig. 59, then select on this line a radial centre as C, preferably so that the lines which pass through the corners at the top of the leg may form an isosceles triangle; this would ensure that the radial lines used for grading the leg cut the outline at the most convenient angle. A radial tool should now be prepared, having its bottom line equal to the full length of the pattern which is to be graded (as in fig 56), the spaces marked on the perpendicular being the unit of grade, which we will assume is the English size, that is ⅓ inch. The joint and instep lines being marked on the standard, lines should now be drawn from the radial centre C, fig. 59, through the positions where the instep line touches the edge of the pattern as CD and CE; with the radial tool the position of the instep line of the largest size is now located and drawn as FH. It is usual to make ¼ inch difference between the insteps of consecutive sizes (§ 37); since, however, there will be $\frac{1}{16}$ inch difference in the width of the waists of the lasts, it will only be necessary to make provision in the upper for



$\frac{1}{4} - \frac{1}{16}$ inch, *i.e.* $\frac{3}{16}$ inch, and as the pattern only represents one half of the upper, the increase in the length of the instep line from size to size should be $\frac{3}{32}$ inch. Assuming that the standard is size 4 and the largest size required is size 7, then the length of the instep line on size 7 must equal that of size 4 + ($\frac{3}{32}$ × 3) inches (the number of sizes larger); this amount is now marked off from F towards H, and from the point now obtained a line is drawn passing through the position where the joint line of size 4 cuts the bottom of the standard, as KJ: DC is now produced until it cuts JK in J, and JL drawn parallel to FH, cutting AB in L, *which is the position of the new radial centre*, and if the radial lines are drawn from L but with the radial tool *measured from* C the necessary grade will be obtained.

The reason of the foregoing is as follows: supposing that it is desired to produce a triangle the base of which shall equal EF, fig. 60, and which shall have two sides passing through the points C, D, the distance between the two parallel lines CD and EF to remain unchanged and the apex of the triangle to fall on AB. Draw a line from F through D and produce it, the line EC is now produced through J until it meets FD produced at H. This triangle EHF has EF for its base and passes through C and D, but its apex does not fall on AB; therefore draw a line HK parallel to EF from H, and where it cuts

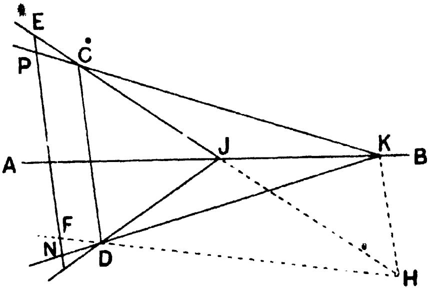


Fig. 60.

the line AB will be the position of the apex of the desired triangle, the distance between the points EF and PN being equal.

Radial lines may be drawn from L, fig. 59, for the whole of the pattern between the instep and the toe, *the distances being measured from* C *on the radial tool.* Between consecutive sizes the difference in joint girth is generally ¼ inch, but as the bottom of the last at the joints would increase in width $\frac{1}{12}$ inch, it follows that provision must be made in the pattern for ¼ inch, minus $\frac{1}{12}$ inch, divided by 2, since the pattern represents only one side of the last, therefore at the joints the grade on the pattern in this case should be $\frac{1}{12}$ inch. It will generally be found that radial lines drawn from L, fig. 59, will give the desired grade, but should it be otherwise a new radial centre could be obtained by the method described for the instep.

The importance of an accurate grade at the instep can hardly be emphasised too strongly, since:—

(*a*) The outline of the pattern from the vamp to the top of the leg is not altered by the process of lasting, therefore if each pattern is the set is not identical in style the boots when made will not appear to belong to the same set.

(*b*) The effect on the long heel measure may be very serious, because of the result on the inclination of the leg brought about during lasting when this measure is not correct (see §§ 60-61).

It is different with the joint measurement, since if this is less than it should be the work of the laster may be more difficult and the amount lapped on the insole may be less than usual, but the effects are not seen in the finished boot, neither would they be if the joint measure of the upper was larger than necessary, since the excess would be lasted away, the general character of the boot not being affected in either case.

99. Between H, M and B, fig. 59, only the radial centre C must be used. The part of the pattern which in the front is above the throat, and at the back above the line AB, could also be graded from C, fig. 59; but since the amount of grade at the top would be in proportion to its distance from C, it follows that the higher the leg of the standard pattern the greater will be the difference between consecutive sizes. In practice, however, it is desirable to maintain uniformity in height as far as possible, and it has become customary to make a difference of $\frac{1}{8}$ inch between consecutive sizes in the same range, and that this may be done without the general appearance of the boot suffering thereby it will be necessary to adopt some method of which the following is typical. Measure the height of the standard pattern from N to P and in the direction of Q mark off this distance *from the bottom of the largest size being graded* as at R, adding $\frac{1}{8}$ inch for each size between the standard and the largest pattern; thus the point S will be obtained. Now find on the grading tool a position which would give the grade PS for *three* extra sizes, 5, 6, 7, and the distance of this position from the commencement of the grading tool, if marked off from P, will locate the position T, which will be used as the radial centre not for the direction of the lines as these are drawn from C, but for finding the amount of grade at each position. Another method of obtaining similar results is to construct a tool the base of which equals the full height of the pattern, the unit of grade set off on the perpendicular being $\frac{1}{8}$ inch, in this case it will be necessary to use the tool for the bottom of the pattern between H and M, fig. 59, as well as the leg; the radial centre C being always used. The effect of this adaptation of the ordinary radial method can be seen by fig. 59, the dotted lines indicating what the outline of the pattern would have been by that system.

100. The various sections—as vamps, goloshes, etc.—may be traced on the standard and graded at the same time as the set of standards, otherwise they may be graded separately. For grading the parts, the original standard can be traced on a sheet of paper, using the same radial centres, whether for the grade of the joint, instep, or leg, and hence the same radial tools. Fig. 62 illustrates the grading of vamps, using the toe as the radial centre; the grade of the joint has not been

adapted but the principle of the method used in fig. 57 could be employed if necessary.

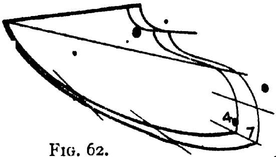


FIG. 62.

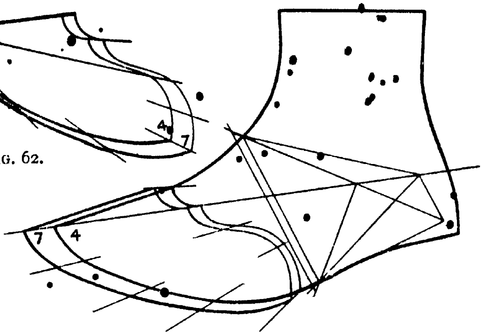


FIG. 61.

101. Many modern lasts differ so much in their two sides that when both sides of the upper are alike it is practically impossible in lasting to get the seams on the two sides to correspond; in such circumstances it is not unusual to make some difference between the two sides, the patterns being described as "right and left," because the upper could then only be made on the foot for which it was designed. It will often be found by experiment that if the heel seam is fixed in position the front can also be correctly placed, but as a result the toe may be unsatisfactory; it would further be observed that on one side of the last there is an excess of material, and on the other side a corresponding deficiency.

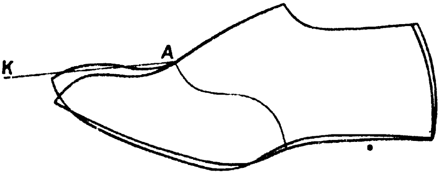


FIG. 63.

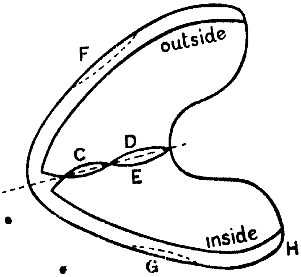


FIG. 64.

The difficulty may be surmounted as follows: Having cut outside and inside formes, trace the inside form on a sheet of paper and design the vamp—if there is to be one. Now take the outside forme and trace this on top of the inside forme, so arranging it that the patterns are in correct position at the heel while the front lines meet at the vamp position as at A, fig. 63. If the formes have been taken off the last with paper sufficiently transparent, each may now be placed upon the tracing and the vamp curve marked on these formes, after which cut them off at the vamp curve and place them as at fig. 64, allowing the toes to overlap at C according to the probable stretch of the material. The greater the stretching property, the less difficulty the laster will have in removing the excess material at D and E.

A reduction may be made both at F and G corresponding to the amount which D and E stand away from the dotted line. If outside and inside quarters are not used the size of the vamp at H must be increased to the size of the outside forme at this place, otherwise the vamper will have a difficulty. The other portion of the pattern may be designed in the ordinary way. Sometimes a difference is made between the two sides of the cue of the vamp; it is not often that this is necessary, but if it is considered expedient the vamp could be cut out of paper and placed on the last to determine how much alteration that particular last requires.

102. Another method of obtaining the vamp would be as follows: After tracing the formes as already described (fig. 63) a line is drawn midway as AK; to cut the pattern for the inside the toe would be raised to this line, thus slightly increasing the length of the bottom outline, and for the outer side the toe would be lowered to the line AK, thus somewhat contracting its bottom outline, the slight alteration in the length of these two lines does not interfere with the correct lasting of the shoe.

103. Other considerations however may be equal, if not greater, than the difficulty of lasting, since the *economy of material* which may be effected is often very considerable, and this may make right and left patterns desirable even when other circumstances may not make them necessary; it is with the vamp and toe-cap that the greatest economy can be effected, the amount being indicated by the difference between the inside and outside formes.

Right and left patterns are sometimes a great advantage to the clicker as it enables him to cut into a vamp material which is not equally good at both wings, since he can be certain that provided he cuts the good material into the outside wing the laster will put it at the side intended, whereas if this were doubtful he could not use it, since should the weak part be put at the outside the utility and value of the shoe would be impaired.

In § 168 reference is made to "Clicking machines"; one great disadvantage with these is the cost of knives, therefore it is advisable to make each pattern as serviceable as possible, since this helps to reduce the expense. For example, the same quarter pattern may be used for several lasts, often with the same vamps, but where better results could be obtained with using different vamp patterns this alteration may be made. Sometimes the same vamp pattern may be used for several lasts and a different quarter pattern used. Where the foregoing method of economy is intended it will be a great advantage to standardize the back curve of the lasts; this does not in the least adversely affect the style of the shoes while it has many advantages, since it reduces the risk in cutting material to stock, and also greatly facilitates uniformity in quality by making better sorting possible, and the latter obviously tends to economy. In addition there is the further advantage that fewer moulds will be required for the stiffeners (see § 324).

The advantages, however, are not so great with boots as with shoes, since different standards would be required for each height of heel as 1 inch, 1¼ inches, 1½ inches, etc., and also for the different fittings, but even then great economy can be effected.

104. Having designed the pattern and cut the various sections, the next consideration will be the production of working patterns, *i.e.* patterns to be used in the clicking-room. Where the work is to be cut by hand it is advisable that the patterns should be reproduced in some material which is less liable to be damaged in shape than pattern paper.

Several materials have been used, fibre-board, zinc, sheet-iron, and straw-board bound with a metal rim. Sheet-iron is the most difficult to use since it is not easily kept in position because it does not yield to the pressure of the fingers; the edge is also so thin that it does not afford such a good outline to cut by as the bound pattern; this is a great disadvantage, especially when the leather is also thin, and the cutting board is hard. Both zinc and sheet-iron patterns are fast disappearing from general use because they take longer to produce and are also more expensive than the bound patterns.

The binding of the patterns with thin metal that is already grooved is a simple operation which is sometimes entrusted to girls. The metal rim is made to conform to the outline of the pattern by placing it in position and then gently pressing it against a circular disc of suitable size, a selection being provided. When it is moulded to the outline its two edges are slightly sunk into the pattern with the aid of a special machine and thus it is kept in position. It is usual to commence the binding at a corner and end at the same place, special machines being supplied for cutting away a mitre to facilitate the binding at sharp angles, and to cut off the binding at the desired length, and finally a small file is used to smooth the join which is sometimes soldered.

It is very important that prick holes should be used to denote the amount allowed for all lapped seams, and with fabrics this applies also to closed seams; accuracy is so necessary that even the pattern cutter with his trained eye, and the time at his disposal, does not trust to his skill but uses a gauge, it should not therefore be left to the less trained eye of the machinist who is also restricted in time. The mark enables the machinist to work with more confidence since there is less probability of error, and consequently the strain of the day's work being less, there is greater probability of efficiency being maintained. The marks should always be put where they will be most useful, and when patterns are cut from material which would quickly get worn—as straw-board—the holes should be protected with small eyelets made for the purpose.

105. Although the principles of grading have been discussed in detail, yet in practice most of it is done by machine; some of these only enlarge the pattern proportionally, just as the radial method would, others can be adjusted to give the desired grade at any part of the pattern. The machine may only mark the size of each pattern in the set, or it may cut it from stout paper or even from straw-board, in which case it would be ready for binding.

In selecting a machine the most important considerations are:—

(*a*) The accuracy of the work it is capable of doing.
(*b*) Its cost.
(*c*) The amount of service which would be required of it.
(*d*) The probable life of the machine.
(*e*) The probable cost of repairs.

When the machine is very expensive, and the service required is only small, the amount which would be saved by using it may not equal the loss caused by so much money being locked up, under which circumstances it could not be considered a wise investment.

DIRECTOR OF
Bengal

CHAPTER XI.

UPPER LEATHERS.

106. THERE are many kinds of leather used in the uppers of boots, and that these may be arranged in order of merit for specific purposes the qualifications which an ideal leather should possess must first be considered; they may be tabulated as follows:—

(*a*) *It must be pliable* (unless it is for those parts of very heavy boots which do not bend with the movements of the foot, as the vamps of shoes with wood soles, or the vamps of navvies' boots, the soles of which are too stout to allow them to be flexed with the movement of the foot). This pliability is essential for comfort, hence the degree of suppleness often decides its claim to priority.

(*b*) *It should be tough*, otherwise it would quickly tear when strained, especially at the button-holes or lace-holes; but this qualification would not be so essential in a topband which is not subject to such strain; for the outsides of uppers, however, it is an indispensable qualification, otherwise to last the boots would be almost an impossibility.

(*c*) It should be *capable of withstanding fatigue*; some leathers have considerable tensile strength, yet if bent many times at the same place they give way, the fibres being too short, too rigid, and too compact to enable them to adapt themselves to the movement of the leather; such material, however, may have other qualifications which would make it a desirable leather for parts of the upper which are not liable to this stress, as for example the toe-caps, or back goloshes.

(*d*) *Ability to withstand abrasive friction* is sometimes an important feature, for example in heavy leathers such as would be used for farmers' boots, shooting boots, or workmen's heavy boots; either of these may often forcibly come into contact with sharp stones; hence leathers, otherwise desirable, being tender on the face, may for this reason be unsuitable, but obviously this qualification is not essential in women's or men's very light goods.

(*e*) That leather be *waterproof* is sometimes indispensable, yet not always, the importance of this feature entirely depending upon the conditions under which it is anticipated that the particular boot or shoe will be worn.

(*f*) Leather should *not be air-tight*, otherwise the foot will always be damp and cold, as a result of the condensed moisture from the foot;

this is especially one of the defects with japanned goods, and with crup, although in a less degree.

(*g*) A special feature with coloured leathers is that it should be possible to clean them; while with very few exceptions (as miners' and farm-labourers' boots) they should be capable of a high surface polish.

107. In endeavouring to secure the ideal leather, many methods are used, each of which produces a leather which possesses some one or more of the ideal qualifications in a remarkable degree, hence it follows that as different features are requisite in different kinds of footwear, or even in different parts of the same boot, so leathers produced by different methods can with great advantage be utilized.

The methods used may be classed in the following groups :—

(*a*) Vegetable tannage.
(*b*) Mineral tannage.
(*c*) Combination tannage.
(*d*) Tawing.
(*e*) Oil dressing.

108. In the production of upper leathers many classes of skin are employed, including the sheep, goat, horse, deer, ox, buffalo, pig, kangaroo, seal, porpoise, white whale, lizard, snake, and crocodile. Most of these can easily be identified either by their section or the arrangement of the pattern of the hair follicles, although the general structure of the skin is very similar in all mammals.

109. The skin is composed of two principal layers, the *Dermis* and the *Epidermis*. The *Epidermis* or scarf skin (which is sometimes called the *epithelium* or *cuticle*) is composed of two layers, the second or basic one being called the *Rete Mucosum*, *Malpighi's net*, or *Areolar tissue*. Both layers of the epidermis are composed of cells, the second one being a soft mucous layer of living cells which are granular in shape; as new cells are formed they force the older ones to the surface, which causes them to become flatter and drier, thus losing their nature; the dead cells are finally thrown off as scurf.

The epidermis [1] structures belong to the class of keratins which are closely related to coagulated albumin. The epidermis is insoluble in water, alcohol, and dilute acids, but strong acids soften, and ultimately dissolve it, while solutions of caustic alkalies, as soda and potash, freely dissolve it.[2]

110. The second principal layer, called the *Dermis*, *Cutis*, *Corium*, or true skin, is distinct from the epidermis in structure and chemical composition, the former consisting of cells but the latter of interlacing fibres which are coarse on the flesh side, coarser in the middle, suddenly become fine in the grain—*pars papillaris*,—and very fine in the *Hyaline*, or *glassy layer*, this being the uppermost layer of the dermis. The last-named layer is very thin and hard, and forms the thin buff-coloured grain of tanned leather, and if it is removed from any part

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[1] Proctor, "Principles of Leather Manufacture," p. 56.

[2] Watt, "Leather Manufacture," p. 23.

prior to the tanning, the place after tanning will be considerably lighter in colour than the rest.

The cause of the apparent difference in the size of the fibres is that the flesh and middle fibres consist of bundles of finer ones which are cemented together by a gelatinous substance, whereas in the grain or *pars papillaris* they are not, neither are they in the hyaline layer where, indeed, the fibres are so fine as to be scarcely distinguishable.

111. The fibres are of two kinds, one (called connective tissue) being white, and the other yellow; they differ not only in colour but in character and chemical composition. The yellow fibres are a highly elastic tissue, their minute fibrillæ are so arranged that in interlacing they repeatedly cross each other, the interstices being filled principally with the white fibres. The yellow fibres belong to the keratins,[1] the proportion of yellow to white fibres being about 1 to 100. "If a thin section of hide be soaked for a few minutes in a mixture of equal parts of water, glycerine, and strong acetic acid, and then examined under the microscope, the white fibres become swollen and transparent, the yellow fibres may then be seen since they are scarcely affected by the acid. White connective tissue is converted into gelatine by boiling with water, but the yellow fibres are not completely dissolved even by prolonged boiling, while acetic acid and hot solutions of caustic alkalis scarcely attack them; they do not appear to combine with tannin and are very little changed in the tanning process."[2] The white fibres are more dense and can resist more than the yellow ones, therefore their proportion is greater in those parts which are subject to much friction. Between the fibres of the dermis there is a variable amount of interfibrillar matter known as hide-substance, lymph, or coriin, which nourishes the whole skin and gradually changes into fibre; it is readily dissolved by limewater, which does not affect the white fibres. The epidermis is not supplied with either blood-vessels or nerves but both are found in the dermis.

112. The hair is developed from the epidermis, each hair being surrounded by a sheath which is continuous with the epidermis but which the hair does not perforate; it is as though each hair had been pressed on the epidermis, the latter allowing itself to be depressed by the hair which is held in the pits thus formed. The root end of each hair is expanded into a bulb having a hollow end into which fits the hair papilla, this being a small conical projection of the *pars papillaris*; the latter takes its name from these projections which form the characteristic grain of the various kinds of leather.

Near where the hair-sheath opens to the surface of the skin the ducts of the *sebaceous* or fat glands pass into the sheath and secrete an oil to lubricate the hair; these glands must not be confounded with the fat cells found in the middle fibres, the function of which is to keep the skin soft. When hides are split and the flesh portion is used for upper leather it is generally waxed on the flesh side, and made level in substance by splitting away that portion of the middle fibres which contains these cells; other fat cells are also found in the *adipose tissue.*

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[1] Bennett, "Manufacture of Leather," p. 15.
[2] Proctor, *op. cit.* pp. 53, 56, 69.

113. *Panniculus adiposus*, or adipose tissue, is that network of connective tissue which unites the skin to the body of the animal; it is the whitish layer which together with the voluntary muscle and any pieces of fat should be removed in the operation of "green fleshing". The voluntary muscle is a thin layer of red flesh spread over the inner side of the skin of the horse and the ox, and is used for twitching to drive off flies.

114. There are differences in the structure of some skins which render their identification very easy when the section is examined. The skin of the sheep when compared with that of the goat is seen to be very different in its middle fibres, the spaces being very much larger, probably consequent upon the amount of fat which is contained therein; it would seem that this fat is essential to the abundant growth of the wool, since as the latter increases so also does the former, whilst the reverse is evident in those varieties of sheep in which the wool approaches more nearly to hair, the openness of the structure being also less pronounced.

115. If the sheep, the goat, and the deer are considered as links in one chain, it will be found on comparing the sections of the skins that, commencing with the poorest grade of sheep-skin and ending with the deer-skin, the structure of the dermis gradually becomes more regular as regards the grain, middle and flesh fibres, there being most uniformity in the beautiful skin of the deer; to realize the exquisite fineness of the latter a section of white buck-skin should be compared with one of mock buck-skin made from calf-skin, or with buff made from the skin of the buffalo.

116. For shortness and compactness of fibre, however, few skins can vie with that of the white whale save perhaps the buttock portion of the horse; the section of the latter is very remarkable, since in its centre there is a thin layer of very hard and fine fibres which is very little affected by any method of tanning; hence, that the leather may be utilized it is necessary to split away this part; a section of horse butt which is before me measures ·12 inch, the shell being ·02 inch, that is one-sixth of the entire substance.

117. In several instances the hair is set very deeply in the skin, and the fibres around the depressions caused thereby are composed of such very finely interlaced fibres that they contrast sharply with the other portion of the section, appearing lighter in colour, and this often renders identification very easy; for the test, however, the section must be cut in the direction in which the hair bends or lies on the animal's back, since in a cross-section it cannot always be seen.

In seal-skin, the hair being very fine, the sheaths only appear as numerous fine threads, lighter in colour than the other portion and set at an angle of about 45°; as the hair is so deeply set it can be realized why this particular leather is less waterproof than many others; in a section 1 inch long about twenty-five sheaths may be counted.

118. In pig-skin the hair is more scanty and much coarser, hence a fewer number of hair sheaths will be visible on a section 1 inch long, but the hair is so deeply set and the sebaceous glands so large that when the leather is tanned the latter appear as hollows on the flesh side; when the leather is split—as it often is—and the grain split is held to the light, it is seen to be perforated with holes where the hair had been, hence it is too porous to be generally used for uppers, although it is very tough and strong, and because of its porousness excellent footwear could be made for use in summer.

Camel-hide can easily be recognized by its section, since there are two distinct coats of hair, one being coarse, long and set deep, the hair sheaths penetrating about three-quarters the thickness of the dermis, the other coat being fine and short, its smaller hair sheaths only extending about half-way through the dermis; these sheaths are almost perpendicular to the surface.

The arrangement of the hair follicles is often of great assistance in identification. In camel-hide they form distinct groups, but varying in number, the larger hairs on the upper side hanging down over a similar number of finer hairs.

In the goat the hair follicles are arranged in parallel wavy rows, the second row being very fine; when the leather has a heavy coat of dressing they are sometimes difficult to see, although on fine grade glacé they can be plainly discerned with a lens of moderate power.

In the sheep-skin the fineness of the wool causes the follicles to be very small and they are not set in any recognizable order. In the horse-hide the hair follicles are finer than in a corresponding part of cow-hide, but since in the latter the size varies so much with the age, sex, and breed, it is difficult to make comparisons; no arrangement in their disposition can be traced. In the buffalo they are much farther apart than in other beef-hides, and this, together with the size of the follicles, renders identification easy.

119. Skins are generally received by tanners in one of the following conditions:—

(*a*) "Green hides," or skins, are such as have not been treated to retard or prevent putrefaction; they are sometimes termed "market hides".

(*b*) "Dried hides" are first washed to free them from blood and dirt, after which they are hung to dry, often in the sun, but preferably in the shade, where there is a good draught of air; they must be thoroughly dried, for dampness will assist putrefaction, but when quite dry they can be kept a long time without deterioration. Hides must not be dried too rapidly as they may then become "case-hardened," the outside becoming so very dry and hard that the moisture cannot escape from the inside; this often results in the destruction of the centre of the substance, in consequence the leather tanned from such hides is sometimes in two distinct pieces, that is the flesh side separate from the grain side.

(*c*) "Dry salted," being used principally for heavy beef-hides; the method is described in § 194.

(*d*) "Plaster cures." A method used in India. The skins having been washed to free them from blood and dirt are painted over on the flesh side with a mixture made from a whitish earth found in the districts of Agra, Delhi, Patna, and Lucknow; they are then put in sheds to dry and after about twenty-four hours are again painted, the mixture being well scoured over the skin with pieces of porous brick, after which they are thoroughly dried. According to Professor Kohnstein[1] the mineral matter used, if calculated on the weight of the skin, gives about 13 per cent magnesium sulphate and 3½ per cent sodium sulphate; magnesium sulphate has the power of precipitating albuminous substances and therefore the skin undergoes a sort of tannage, the capacity of absorbing water being thereby reduced. It is used principally for goat-skins and kips.

(*e*) "Wet salted"; after washing, salt equal to about 25 per cent of the weight of the hide or skin is thrown over the flesh side, which is then folded down the back and the edges turned in, thus making a square parcel which is tied for ease in handling; the method is used for beef-hides.

(*f*) "Pickled"; after unwoolling, sheep-skins are often "pickled" by the fellmonger, in which condition they can without injury be kept for many months, this enabling the owner to await a favourable market; the skins are first swollen with acid—either sulphuric or formic—and afterwards reduced with common salt. Pickled skins may be stored in barrels, or else dried.

120. The first process at the tan-yard is to cleanse "green hides" to free them from blood and dirt; but such as have been dried or treated by another method to prevent putrefaction must be cleansed from the antiseptic used and brought to the "green" condition, the process being as follows for beef-hides—calf, kip, or cowhides—that are to be used for upper leather; tanners, however, may vary the method considerably.

The skins are soaked for about two days in water to which a small quantity of caustic soda or sulphide of sodium has been added; when sufficiently soft they are roughly fleshed, the soaking is then continued, sulphide of sodium or formic acid often being used to hasten and complete the softening, which must be thorough. Bacterial action must not be permitted, since the result would be a loss of hide substance and the grain may also suffer. When satisfactorily softened and after careful washing the hides will be ready for liming, preparatory to unhairing. The skins are put into pits containing water to which has been added ordinary slaked lime (calcium hydrate); three or more pits may be used, the skins being first put into the liquor which has been previously used on two occasions, the pit containing lime not previously used being reserved for the final soaking; when the hair can be pulled with the thumb and finger the unhairing may be performed. By the process of liming the areolar tissue and hair roots are attacked, these being softer than the epidermis and hair which are not much affected; chemists, however, have not yet agreed as to the relative importance of the action of the lime, the bacteria and the ammonia which develop in the old limes, but it is well known that old limes are more effective than the fresh.

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[1] "Leather World," 16 April, 1914.

121. There are many methods of de-woolling sheep-skins, the selection of the method generally depending upon either the market value of the wool or of the pelt. The work is generally done by the fellmonger, who is often more interested in performing the operation in such a manner that the wool is in the best possible condition rather than that the pelt be damaged as little as possible, consequently putrefaction is not very carefully guarded against.

In many instances the method of de-woolling selected is that known as "putrefactive fermentation"; when putrefaction sets in the areolar tissue is the first to be affected, the result being that the epithelium is loosened from the hyaline layer; the wool which is held in the folds of the epidermis may now be easily removed by pulling, and for this reason putrefaction is often induced in sheep-skins by laying them in piles for a short time; the method however has its disadvantages, since the skin becomes flaccid, the fat has not been acted upon, and the cementing substance which binds the fibres together has not been dissolved; consequently it will be necessary to put the pelts into milk of lime as soon as the wool is removed. Often the skins are painted on the flesh side with a mixture of sulphide of sodium and lime, the skins being then folded, flesh inside, and allowed to stand until the next day, when the wool should be pulled, the skins being afterwards well washed to remove the sulphide previous to putting them into milk of lime.

When the wool or hair is not valued, the skins many be painted with sulphide on the hair side, and in a few hours both the hair and epidermis will be reduced to a pulp, so that it can be removed, care however is necessary with its use. When skins are de-woolled by a fellmonger who is not also the tanner, it will be necessary to treat them in such a way that they can be kept until there is a favourable market; the usual method being to pickle the skins (see § 119).

122. The method of removing the hair (not wool) is as follows: The skin is placed on a curved surface termed a "beam," the hair and epidermis being pushed off with an unhairing knife, which is a double-handled tool, having its edges dull and less concave in shape than the convexity of the beam. The operation is sometimes performed by machine, the skin being passed under a revolving cylinder having a number of raised ribs set in different directions; as the cylinder revolves the hair and epidermis are removed.

123. After unhairing the skins are well washed, when the fleshing may be completed, the operation being performed over a "beam" with a fleshing knife, which is a double-handled tool having a concave-shaped blade, but it is used with its flat side resting on the pelt, whereas the

unhairing knife is held almost perpendicularly. Fleshing may also be performed by machine, especially when the pelts, as they are now called, are afterwards to be split. The fleshing machine is similar to that used for unhairing, except that its raised ribs, or knives, have keener edges.

The splitting is done with a machine having an endless-band knife fixed at the back of a revolving cylinder under which the pelt is drawn, being pressed against it with suitable devices which adapt themselves to the varying substance; the knife travels rapidly over pulleys, there being one at either end of the machine; excellent work may be done on it, hence it is possible to produce large quantities of leather that is uniform in substance at a cost much lower than would be possible with hand-shaving; it also has the additional advantages that the cost of tanning this portion is saved, and the increased commercial value of that which is taken off (§ 147). When it is intended to use as leather the part which is split off the operation is often delayed until after tanning (§ 139).

124. Immediately following this operation the pelts will be *delimed*, the object being to neutralize any lime which may be present; this can be done in several ways, it being not unusual to use either lactic, hydrochloric, formic, or boracic acid; unless the work is carefully done the leather will be brittle on the grain, besides which the subsequent operations will be rendered difficult.

125. *Bating* should follow next; in this process a lixivium of hens' or pigeons' dung would be used; this is prepared, allowed to ferment, diluted, and strained, after which the pelts are immersed in it until they are sufficiently reduced in substance, and have acquired the desired degree of suppleness, the latter resulting from the more complete solution of the cementing substance which bound the fibres into bundles. When it is essential that it shall be possible to stretch the finished leather in any direction without there being the slightest tendency to spring back, then a still greater reduction may be necessary, the finished leather then being more porous; to accomplish this the lixivium may be used warm, but it must not be used so hot that the skin is thereby damaged. If dogs' dung is employed the process is described as *puering*; and the liquid would then be used warm.

126. *Drenching* usually follows puering and bating; its object is twofold, since it cleanses the pelts from the lixivium, and the lactic and acetic acids which develop in the drench, remove any remaining lime. Ordinary bran is used in making the drench, it being steeped and allowed to remain until fermentation has taken place; the pelts are placed in this and worked about until they acquire a satisfactory "feel and appearance". Many experiments have been made to find a substitute for the puer and bate which would be less objectionable, possibly in the near future they may be superseded; at present, "Oropon," "Erodin," and "Enzo," are gaining in popularity. The pelts must now be forcibly scraped on the grain side to remove hair-roots or fat glands, and to cleanse the surface, the operation being known as "scudding".

127. Before referring to the method of using the tanning agent some details may be given of the principal agents used.

Hemlock extract is obtained from the wood and bark of the spruce fir, *Abies Canadensis*, which grows abundantly in the Northern States of America (§ 128).

Gambier arrives in this country in the form of an extract made from the plant *Uncaria Gambir* and is imported principally from Singapore. It is also known as Catechu, Cashew, Cutch and Terra Japonica.

Sumach in commercial form is a powder made from the leaves and young branches of the *Rhus coriaria* and *R. cotinus* (wild olive). It is a shrub growing wild in Portugal, Spain, Italy and France.

Mimosa bark is obtained from various species of acacia; it abounds in Australia and South Africa.

Larch extract, obtained from the Hungarian larch, is said to be increasing in favour with English tanners.

Turwar bark (*Cassia Auriculata*) comes from Hindostan. Many East India kips, goat and sheep-skins, are tanned with it.

Oak bark is obtained from several varieties of oak, in England the common oak being generally used.

128. In America the larger skins used for upper leather are first slit down the back, being then described as "side leather"; hemlock extract is the tanning agent often used. In Australia the principal tanning agent used is mimosa, but in India many of the best kips and calf-skins are tanned with Turwar bark, an excellent leather being produced. Sumach is more general in France, and Oak bark in England; but transport facilities are at present so great that the use of any tanning agent is not now restricted to the place of its origin.

129. The general method of using any tanning agent for upper leather would be as follows: Strong liquors are made with the selected materials and the pelts placed in them, sometimes only a small machine known as a paddle is used, often a large revolving drum takes its place; the heavier hides and kips, however, used for vegetable-tanned upper leathers, would go through similar processes to those described in §§ 225-7; although, being thinner and more open in texture, as a result of the earlier treatment (§§ 125-6), they do not offer such resistance to the penetration of the tanning agent, and therefore less time will be necessary. On the Continent the lighter skins are often tanned in vats, and instead of being passed from one vat to another they would be taken out and allowed to drain while the liquor was being strengthened; they would then be returned to the same vat, the process being repeated until the tanning was satisfactory. The advantage of using the drum is that much of the labour of "handling" is avoided, while there is a decided save in the time required for the penetration of the liquors. The time occupied with the actual process of tanning will depend upon:—

(*a*) The substance of the pelt;
(*b*) The tanning agents used;
(*c*) The method employed.

When the tanning is satisfactory, the leather must be carefully washed and dried; it will then be ready for subsequent operations (§ 138).

130. One of the most popular methods of producing upper leathers is by the chrome process; this changes the nature of the skin so that it is both non-putrescent and very pliable. It differs considerably from vegetable-tanned leather since it may be subjected to boiling water without being in the least affected, whereas the former would shrivel up and become brittle. Leather that is chrome tanned is also less bibulous than vegetable-tanned leather (see § 250), hence it makes an excellent material for boots that are to be worn under damp conditions, but being always finished with the grain outside, and this being rather tender, it is not so suitable for that rough wear which a navvy's boot might receive. The process of chroming does not affect the gelatinous part of the pelt in the same way as the vegetable-tanning process; the hide substance, which by the latter process is changed to tanno-gelatine, is not utilized by the former process, consequently the leather is not so well filled. Another feature of the leather is that being non-absorbent it does not take up the perspiration from the foot, and since it is not able to escape as with leathers which are more porous, this moisture is condensed and in some cases causes the feet to be cold, clammy, or even wet, according to the constitution of the wearer.

131. The preliminary processes, so far as the conclusion of the bating, may be similar to that which has been already described (§§ 120-6); the process known as "pickling" now follows, the pelts being drummed with a mixture of sulphuric acid and salt, 5 lb. of the former being used to 40 lb. of the latter, in 40 gallons of water, the object being a more thorough separation of the fibres from the bundles. The skins are next put into a solution containing common salt, hydrochloric acid and bichromate of soda; after drumming for about one and a half hours they are removed and put on horses to drain until the next day, when, after dipping in a solution containing bisulphite of soda, they would again be placed in the drum, a solution being added containing bisulphite of soda, common salt and hydrochloric acid; in about one and a half hours they will be removed and again drained, and finally the acidity of the leather is neutralized with borax or bicarbonate of soda.

132. Sometimes only one bath is used, the skins being first drummed in a solution to which common salt is added, a similar weight of "Tanolin" is then dissolved and gradually added to the previous liquor, to this bicarbonate of soda is added, the amount being about one-twelfth of the weight of salt used. When thoroughly tanned the leather is taken out, drained on the horse for forty-eight hours and then neutralized.

133. Sometimes—especially with heavy hides—the tanning may be performed by suspending the hides in pits, the hides being worked up the yard to pits of increasing strength as with vegetable tannage, but when handled this way the penetration is less rapid. According to Professor Proctor, mineral tannage depends upon the skin absorbing a basic salt; but basic salt *as such* is not directly absorbed by the skin.

The skin is therefore first impregnated with chromic acid, which may be done in a bath containing potassium bichromate and hydrochloric acid, (which will produce chromic acid); this is next changed to a basic salt by introducing a *reducing agent* to remove some of the oxygen, the tanning being then completed; the latter is accomplished by submitting the skins to a second bath containing sodium thiosulphate and hydrochloric acid, this produces thiosulphuric acid which is a reducing agent and seizes some oxygen from the chromic acid and leaves it a basic chrome salt.

The process just described is "chrome tannage," but if the skins are first "pickled" as described in § 131 (but using salt and alum instead of salt and acid) it would be "chrome and alumina" tannage. The finishing would be as in § 144.

134. Many East India kips are tanned previous to their exportation, and as there is a greater demand for chrome leather than for that which is vegetable tanned the latter tannage is often put through a chroming process, being then described as "semi-chromed". In America many of the light packer hides are used in the production of semi-chrome leathers; these may be tanned with hemlock, with gambier, or with a combination of tanning agents.

As they are already vegetable tanned the goods must be sufficiently mellowed for shaving or splitting, after which they are drummed with plenty of water to which borax has been added, the object being to remove everything which might wash out and adversely affect the chrome liquors; this process is known as "stripping". The chroming process may now follow as in §§ 131-2, the liquors being strengthened until the leather will not assimilate any more, which can be easily seen since the colour of the liquor would not then become any weaker. The neutralization and finishing of the leather may be as for full chrome leather.

135. Until quite recently "calf-kid" (made from calf-skin) was very popular, but it is now almost discarded in favour of leather with a brilliant face. It was prepared by a method known as "tawing," which differs from other processes in that the gelatine remains unchanged; consequently, when boiled, such leather can be gradually dissolved, and the liquid when poured off will "set," it being gelatine. Tawed leathers are therefore not suitable for the uppers of boots which would be subjected to much damp, but since so much of the nature is left in the fibre it is the most popular method of preparing leathers for gloves, although the skins then used are principally lamb, only a comparatively few "kid" (young goat) skins being used.

The usual method after the preliminary processes (§§ 120-6) is to soak or drum the skins in alum and salt, the proportion of which may be two of the former to one of the latter. After about two weeks the skins may be tested by firmly pressing a fold of the skin, if this then appears as an opaque white streak, the tanning is complete.

The skins are now hung up until thoroughly dry, after which they will be mellowed by soaking in water, and then "staked"; the principle is similar to that in § 148, but the method differs, since in this case the skin having been fastened by one corner to a post is then held taut with the left hand while it is forcibly scraped on the flesh side with a tool held in the right; the tool used—the moon-knife—is a flat, circular disc of steel, with a handle across the round hole in its centre. After shaving or otherwise levelling, the skins go through a process of "egging"; a mixture of flour, egg-yolk, and olive-oil is made into a paste with water, this is put into a drum with the skins; when they will absorb no more of the mixture, and with the paste still adhering, they are hung up for a month to "age" and dry thoroughly. After having been soaked in water and cleaned the skins will be ready for dyeing, the process depending upon the colour and the kind of dye used, but if for black calf kid the skins would first be mordanted with logwood, after which a solution of iron is used, usually ferrous sulphate. When dyed and dried out the skins are again softened with the moon-knife; in the case of small skins which have not been shaved, if they are too stout they may be reduced in substance with a moon-knife, having a turned edge; the flesh being finally finished on an emery wheel. Formerly glacé kid was dressed in the foregoing manner, being finally finished with a dressing of wax and oil, which was ironed in, the process being repeated until a satisfactory face was obtained.

When white leathers are wanted for the socks or linings of shoes, sheep-skins are generally used, and these are prepared by the "tawing" process.

136. *Dongola*[1] dressed leather is not as largely used in the shoe trade as leathers dressed by the methods to which reference has been made above, but it should not be ignored since it has several distinctive features. The skins having been de-woolled are de-greased, an operation always very important in sheep-skins because of the amount of fat present in the middle fibres, which is changed by the lime into an insoluble lime-soap and then removed in the after processes. When de-greased the skins are pickled with sulphuric acid and salt (§ 134), after which they are immersed in a 10 per cent salt solution for half an hour, and then in a 3 per cent solution of salt with 2 per cent chalk, the effect of this being further to reduce the swelling of the fibres.

The skins having been washed are tanned, gambier, sulphate of alumina and salt being used; if tanned in a drum the tanning will only take a few hours. After washing and drying, the skins are fat-liquored with soap, neat's foot oil and glycerine, then set out, dried, staked, and finished (*Le Cuir*). If a morocco finish is desired they may be finished as in § 145, or they may be glazed. The special feature of the leather is its suppleness which surpasses that of ordinary vegetable tannages, while at the same time its fullness is greater than that of chrome tannage.

137. Wash-leather is generally made from the flesh-split of sheep-

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[1] It may be noticed that this process is very similar to Newton's, described by Alexander Watt: "The Art of Leather Manufacture" (1897), p. 166.

skins, but the best quality is obtained from very small deer-skins imported in a dried state, many coming from China. The sheep-skins are split just after unhairing, and are then well plumped, and much firmer than they would be after de-liming. The bran-drench follows the splitting, after which the skins are wrung out, and, when sufficiently dry, sprinkled with fish-oil which may be allowed to stand, and work into the skins, or it may have mechanical assistance, being either beaten in by a "fulling mill," or put into a drum; in any case the oil must thoroughly permeate the fibres, care being taken that in the meantime the skins do not get overheated. The excess of oil is now pressed out, after which they are well washed in the drum which further clears them of oil; they are then dried and staked, often being finished on the emery-wheel.

138. The process of vegetable tanning renders the skin "non-putrescent," *i.e.* it could be kept for an indefinite period, whereas previous to tanning putrefaction could eventually have destroyed it; with prolonged soaking it would also have wasted away, but now it is insoluble; furthermore, after wetting, its fibres would have adhered together, thus causing the hide to be hard and stiff, but now this tendency is changed.

The leather, however, is not yet suitable for the uppers of boots.

(*a*) A greater softness or suppleness is desirable.

(*b*) Increased power to resist water penetration is requisite.

(*c*) And a better appearance is necessary.

139. These improvements may be obtained in many different ways in leathers that have been tanned. Calf-skins, kips, and light cow-hides, are sometimes dressed on the flesh side, and sometimes on the grain side. When finished on the flesh side the leather is said to be "curried" and "waxed," the process being as follows: The leather having been well soaked—often in warm sumach—is next laid on a table of mahogany, marble or glass, and scoured on the grain side to clear it of bloom (§ 235) or other deposit, water being used profusely in the operation. The leather is next "set out," that is, all wrinkles are removed with a "slicker" by pushing them in the direction in which the leather will stretch; it is then shaved on the flesh side, the fibres immediately beneath being considerably finer and less marked with veins; besides this the skin will be made more uniform in substance by somewhat reducing its stoutest parts. Shaving and splitting machines have now largely superseded the hand operation. Sometimes that which is split away by the machine is only useful for making "pasted stock" (§ 145), but if stout enough and sufficiently large, it may be properly waxed and used for the tongues or fittings of men's cheap boots. When side leather is split, the grain may be finished as satin hide, glove hide, or box side, and the flesh-split finished by waxing, in which case it may be put through the splitting machine a second time to level it, this being done either from the middle fibres or the flesh fibres according to the fineness of texture; should the split however be too open for waxing it may be given a heavy coating of size and then, when in a suitable condition, be rolled, and afterwards used in the bottoming department.

140. After shaving or splitting, and while the leather is still damp or mellow, it is coated on one or both of its sides with "dubbin," which is a mixture of cod-oil and tallow, but the ingredients may be varied considerably, according to the character desired in the finished goods; splits which are loose in texture often have an artificial solidity imparted to them by using hard tallow, paraffin-wax, or crude stearic acid.

The leather having been "dubbined," is hung up in a moderate heat, and as the moisture dries out from the leather, it leaves space which is soon occupied by the grease; the effect on the leather is to coat its fibres with fat, and also to some extent to effect a change in the fibres similar to that in oil dressing (see § 137); the leather will now be much more supple—unless purposely hardened—and also more impervious to water. As the leather only absorbs the softer portion of the fat—unless assisted with heat—it naturally follows that some of the most solid part will remain on the surface to be removed by a process termed "slicking".

In some towns the leather is placed in large drums in order to effect the stuffing in a shorter time, incidentally it has the further advantages that harder fats and waxes can be used, and that the stuffing may add 50 per cent instead of 10 per cent to the weight, the process occupying about half an hour.

The operation by which the surplus grease is completely removed, either from the grain or flesh sides, is called "whitening," after this a tool is used which in principle is similar to a "buff" knife, except that the operator when using it pushes it from him, hence the edge is not "set" the same as in a buff knife. An exceptionally thin film of leather is removed with this tool, thus clearing away any remaining grease and leaving the flesh side very smooth; when the grain side is also done it removes many minor surface deposits.

141. Leather that is waxed on the flesh side, and that has a grain on the underside (as waxed calf or waxed kip), may now go through a process to improve the appearance of the back, by giving the grain a "pebbled" appearance. The leather is folded over with the grain inside; a board about 10 inches square, having its face covered with cork to enable it to grip the flesh side of the leather, is now used to move the top part of the folded leather backward and forward, thus altering the position of the fold, which is made to travel in the direction of the length of the leather; this operation is known as "boarding" and the effect is to soften the leather by breaking up the grease and separating the fibres.

142. The flesh side of the leather (which will be the face) may now be blackened, using a preparation made with lamp-black and oil or soap; when this has been well worked in, the leather will be ready for the first coating of size, and when sufficiently dry this will be smoothed, by glazing with a smooth glass "slicker". The final coating of size will be similar to the previous one, but gum tragacanth may be added to cause it to dry with a brighter surface.

Because of the difference in the substance and quality of the various parts of the skin and the difficulty the manufacturer may have in economically using up the whole of the leather, it is not at all unusual for the currier to dress it in sections, each section being finished in the most suitable style; therefore the belly on either side may be cut off and then the shoulder separated from the butt (see fig. 95). In the market we may therefore meet with :—

(*a*) Waxed calf-skins.

(*b*) Waxed kip (from full-grown animals which, however, are not as large as the English cow).

(*c*) Waxed kip butts (the shoulder and belly being rounded off; in shape they correspond to the bend).

(*d*) Waxed split sides (from full-grown beef hides slit down the backbone, see § 139).

143. The shoulders and bellies (taken off the kips) are often finished on the grain side, and the processes beyond the stuffing will differ from what has been described above. The grain side of the leather will be carefully whitened to make it as smooth as possible, the face being afterwards brushed over with a solution of soda in water to prepare the surface for dyeing, which generally is performed with a preparation of logwood and ferrous sulphate. The leather afterwards receives a dressing of oil and being turned face downward is worked out in the direction in which it will stretch, then turned over and a similar process performed on the grain side, after which it receives a thin coating of size and is finally dried.

Leather dressed in this way comes into the market as :—

(*a*) Grain shoulders, or bellies; these are unsplit.

(*b*) Satin hides, these being the grain side of split sides tanned with hemlock.

(*c*) Glove hides are the grain side of split sides often tanned with gambier.

(*d*) Glove-hide bellies, these being split leather, therefore differing from (*a*).

144. At the present time leathers with a bright face are in favour, and also the well-known natural grain usual in box calf, consequently it is not surprising to find many imitations of it; therefore the shoulders and bellies from kips as well as the grain side of split sides may be finished as follows : During the stuffing a smaller amount of grease will be worked into the leather, but after this the face will be prepared as for satin hides until after the sizing, when the face will be burnished on a "glazing" machine; this has an oscillating pendulum in the bottom of which is fixed a piece of agate or glass with its edge smoothly rounded; this works upon a wide strip of stout leather, strained taut between two supports, the leather to be glazed being passed under the pendulum; it is afterwards printed, the machine which is used somewhat resembles an ordinary mangle, only the top roller, which may be of steel or gunmetal, is engraved with the desired pattern of grain, and this assists the regular break of the surface in the after process of boarding (§ 141); subsequently it may be finished with a thin coating of size.

Buffalo hides of Indian tannage are often split and worked up for "box sides," and when the hide is a good one an examination of the hair follicles would be the only means of identification.

145. "Goat Morocco" is a vegetable-tanned leather. Morocco in North Africa was once famous for its leather, which appears to have been made from the skins of various animals since, according to Watt,[1] the skins of the goat, calf and sheep were used; the tanning agent being pomegranate, or date bark. The skins were finished on the grain side, the well-known pattern always being developed. The leather has since been largely imitated and in certain districts a distinctive "grain" has been adhered to, hence we still have the recognized types as "Persian," "Strasburg," or "straight grained" Morocco.

Sumach is now often used for tanning morocco leather, which is then "set out," dyed, stuffed with grease, set out, dried on frames, and buffed on the grain to make it smooth, the amount taken off being so thin that it is really only the tips of the papillæ which are removed; the leather is then staked, sized, burnished, and grained—a process similar to boarding. While the above is a general outline of the processes, the price of morocco leather varies so much that it is obvious the price will not permit such elaborate details in the preparation of the cheap grades as in the expensive ones.

Many East Indian goat-skins are dressed as morocco, and are often dyed in colours and used for the outsides of ladies' boots and shoes, for slippers, or for "nursery" goods. A considerable number of East Indian goat-skins are also used for the manufacture of tan glacé kid and goat, it being a difficult problem to decide when a "kid" becomes a "goat"; many authorities urge that when the animal can sustain itself by eating grass it is no longer a "kid"; this may be, but it is not easy to determine in the finished leather whether the former occupant of the skin had ever eaten grass.

146. Sheep-skins may be either vegetable tanned, chromed, or tawed. When vegetable tanned they may be finished on the grain side in any colour, the face being left with a soft finish (similar to the face on gloves cut from vegetable-tanned leather) or glazed. Sheep-skin may be printed with any desired pattern, the variety to choose from being very large, but those most frequently met with are imitations of the more expensive leathers, as seal, morocco, crocodile. The method of finishing would be similar to that in § 144. When "chromed," sheep-skins are usually finished to imitate glacé kid; when "tawed," they are often dyed and used in the glove trade, many of the less perfect of the white skins being used for socks and linings of shoes.

147. Many sheep-skins previous to tanning are split with the band knife, a very thin grain-split being removed (§ 137), this is tanned with sumach, or some other suitable agent, after which it is dyed and finished. In the boot and shoe trade this leather, which is known as "skivers," would be used for topbands, facings, or socks. Sheep-skins are often tanned and then given a "suède" finish; the flesh side is first made

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[1] "Leather Manufacture" (1897), p. 2.

very smooth on an emery-wheel, after which a dye-stuff in the form of a paste is thoroughly worked into the leather, and when quite dry it is scoured off on a fine emery-wheel. Sheep-skins which are badly damaged on the grain side are often dyed and finished in this way to imitate chamois or "shammy" (see § 137). Such skins are usually unsplit.

148. Leathers that have been chrome-tanned, while still in a moist condition, should be "set out" on a table as already described (§ 139), after which they would be drummed with an emulsion of oil and soap; this makes the leather softer and prepares it for the subsequent processes. The dyeing of the leather may be done on a table with a brush, or in a drum, and when in a suitable condition—not being either too wet or too dry—the leather will go through a further process of softening called "staking," the leather being stretched over the end of an upright, or "stake"; the hand-method, however, is now almost obsolete, since the staking machine, which is just as efficient, effects a considerable economy both in time and labour. The machine has an arm which coming towards the operator descends on the material with an adjustable pressure, the arm is then drawn back, the operator meanwhile holding the leather in position while it is pulled out by the friction of the retreating arm. A thin dressing is used on the face to assist the glazing, which is performed while the surface is still damp (§ 144). Full chrome leathers are usually fastened to frames of suitable size for complete drying.

149. *Basils* are sheep-skins tanned with *barks*,[1] Australian basils being tanned with mimosa; in Scotland larch is used, and in the West of England oak bark; the leather is usually rather harsh and its use is generally restricted to lining the commoner classes of strong boots and in the saddlery trade. It may be left in the "rough" or be dyed and glazed or printed.

Roans are medium-weight sheep-skins generally tanned with sumach, usually the process only taking about twenty-four hours; the skins are sewn up and filled with sumach liquor, the distended skins being then also put into warm sumach liquor; they are presently piled on a draining board and submitted to pressure, which squeezes the liquor out of the skin; when the process has been repeated the tanning will be complete. The finishing processes include damping the dried skins, setting out, nailing on boards to dry, clearing the grain with acid, dyeing, again setting out, drying, glazing, and graining, the distinctive grain being the result of graining in one direction only, that is from the butt to the neck. "Willow" grain, which resembles the shape of a willow leaf, is also obtained by boarding in one direction only, that being from head to tail. "Box" grain is rectangular, and is obtained by boarding in two directions, the second being at right angles to the first. "Morocco" grain is produced by boarding diagonally.

150. *Russia leather.* In the tanning of this famous leather willow-

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[1] Watt, *op. cit.*, p. 39.

bark is used; the peculiar smell being imparted by birch-oil which is used in the currying; the leather may be dyed any desired colour or finished black; it may be left with a smooth face or be printed with its peculiar diamond-shaped grain. Usually it is the skins of calves and young cattle that are used in its manufacture, although horse-hides, goat and sheep-skins, are also sometimes employed.

Cordovan leather.[1] Formerly this referred to leather which was manufactured at Cordova in Spain from various skins,[2] these being finished similar to morocco in any colour but generally red; that however which is now commercially known either as Cordovan shoulders or bellies is obtained from horse-hides; it is vegetable tanned and finished in the same way as grain shoulders and bellies (see § 143).

Crup is obtained from the butt of horse-hides; after tanning, the shell (§ 116) is split away and the leather is then curried and waxed, usually a very fine face can be obtained, it being generally used for the vamps and goloshes of the more expensive class of men's footwear.

151. *Porpoise hide.* Formerly this was obtained from the skin of the porpoise; when tanned, curried, and waxed on the grain side a very fine leather was produced. On account of the closeness of its texture and the fineness of its fibre it is capable of receiving a very fine polish and of withstanding water-penetration better than leather obtained from beef-hides; consequently it has been in demand for shooting-boots and high-class footwear; its great tensile strength has also won for it an enviable reputation for leather laces, although at the present time those generally supplied are obtained from the hide of the white whale; the cutting surface of the latter is larger and laces more uniform in substance can be obtained, even if the texture is not quite so fine.

Seal-skins were formerly highly esteemed when made into leather for the uppers of boots; the tannage was invariably vegetable, the leather after dyeing or blacking being finished on the grain side with the well-known grain pattern developed, the looseness of the material generally making it impossible to obtain as small a grain as is possible on a goat-skin. The leather is too porous to be waterproof, hence it is unsuitable for those parts where this is essential, but its porosity renders it very suitable for the legs of men's golosh boots, for which purpose it was in favour for a long time (see § 152).

152. *Patent, enamelled, or japanned leather.* Leathers in this group may be classed under three headings:—

(*a*) Vegetable-tanned leathers, finished on the flesh side.

(*b*) Vegetable-tanned leathers, finished on the grain side.

(*c*) Chrome-tanned leathers, finished on the grain side.

Patent calf is in the first group; it is made from calf-skins which are tanned with sumach; after very careful setting-out the skins are worked to a very fine face on the flesh side; the skins are then degreased and fastened to frames, flesh-side up, this being the side which will be enamelled. The foundation coat is composed of Prussian blue, linseed oil, and vegetable-black; this is evenly spread over the leather which is then put into a stove to dry; after cooling the coating is brought to a fine surface with pumice stone; it will be necessary to give the leather three coatings, each of which must be finished with pumice stone; the final coating may contain either copal or amber varnish.

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[1] "Leather World," 1914, p. 641.

[2] Watts, pp. 296 *et seq.*

The introduction of the splitting machine has made it possible to produce a cheaper grade of leather from the flesh side of cow-hides (patent tipping), this being much more flexible than patent calf, since it has not the support of the grain. Its popularity, however, is now on the decline.

Vegetable-tanned seal-skins and horse-hides are both enamelled on the grain side, and with either it is usual to assist the natural break of the grain by printing it, the result being greater uniformity. When enamelled on the grain side, a leather which is much more open in texture may be used, it being evident that seal-skin could not successfully be worked up on the flesh side because of this defect; there is also an important advantage in that the enamel does not require the thick foundation necessary in a split leather. Both leathers are principally used for children's shoes.

Leathers that have been chrome-tanned are finished on the grain side, calf skins, goat-skins (chiefly those from Patna in India), and colt-skins (chiefly imported from Russia, where these animals have very fine coats) are used in the production of this leather, and the large cutting area of the latter probably accounts for its popularity. A few sheep-skins are also used in common work.

The chief feature of chrome-tanned enamelled leather is its suppleness and the openness of its texture, the former enables the leather to be moulded about the toe of a last with ease, the latter assisting the gathering in of the full material; the great improvements which have been made in the elasticity of the enamel ought also to be mentioned.

CHAPTER XII.

THE SELECTION OF UPPER LEATHERS.

153. DIFFERENT skins and different methods of dressing furnish such a very wide range of material that it is difficult to name features which under all circumstances would be desirable; furthermore, the qualities essential in one class of footwear may not be important in another; it is, however, always an advantage when a skin is *well-grown*, *i.e.* when the naturally poor parts are better than usual in quality, because then the proportion of good material is high, but when from any cause the amount of poor material exceeds the normal percentage, the skin would generally be considered *badly-grown* A square skin is usually preferred, because the width of the back furnishes a useful cutting area of good material, whereas when the skin is long from head to butt and narrow across the back, the amount of prime material will be less than normal, besides which it is usual for such skins to be poorer than the average in those parts which are always of lower quality, *viz.* the belly and flanks.

Should the animal have been specially fattened, then the skin may suffer in quality through the growth-marks in the neck and shoulders being so pronounced; on the other hand, animals in poor condition are generally inferior through the backbone being badly marked. The neck is seldom as fine as the back, and the degree of coarseness is often an index to the quality of the skin, since a heavy neck would be a bad feature in leathers purchased by weight; the shanks also should not be left too long, since they are relatively inferior in quality.

154. The goat-skin has the shortest and finest fibre, the calf next, and then the sheep. It may be said that the length and fineness of the fibre largely determine the quality, since if the essential requisites as enumerated in § 106 are considered, it will be evident that the above structural features would be important for each qualification; and as the skins of two animals can be compared for quality by observing the relative length and fineness of their fibres, it will also be evident that since these vary in the different parts of each skin, this variation will also indicate the variation in quality.

The normal distribution of quality and variation of fibre[1] is shown in fig. 65. Substance also varies; generally those parts are thickest where this is desirable for greater protection, and those parts thinnest that are moved with the actions of the animal, as for example, the parts

[1] See § 249.

just in front of the hind-legs, and those immediately behind the fore-legs. The substance is greatest at the butt, it decreases gradually as it approaches the shoulders, the belly being lighter and the thinnest parts those already so described. The neck varies, sometimes being very stout, although generally it is lighter than the butt, but stouter than the shoulder.

155. Goat-skins are often badly "tick"-marked, the animal is also subject to a form of measles which permanently injures the skin; their fighting spirit accounts for many a defect caused by horns, besides which their short coat does not afford a perfect protection from the thorny bushes, the evidence of which is often very apparent.

Sheep-skins generally have fewer blemishes, although a want of care in skinning and fellmongering is often very noticeable.

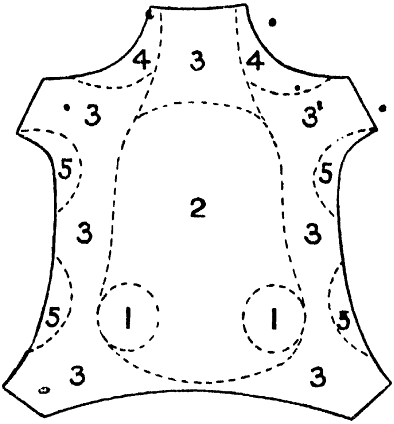

FIG. 65.

Horse-hides are often badly marked in the mane and backbone, especially the older skins.

156. The method of production is responsible for particular features which would not occur in other leathers; these must be observed in considering its quality, besides which the characteristics that adversely affect its quality must not be ignored.

Curried leathers which are waxed should be of mellow tannage, Bordeaux being noted for the excellency of its tanned calf-skins; in this respect a kip suffers in comparison with a calf-skin since it is never as mellow; its quality therefore would be partly decided by the nearness of its resemblance to the calf-skin. The argument, however, does not apply to split leather which is waxed, since in this case the apparent mellowness may be the result of openness or coarseness of fibre, and in wear such would be unsatisfactory; hides of fine texture would be firmer, and a firmness is therefore often obtained by using hard fats, stearic acid, or paraffin wax, but such leather does not stand well in wear. Waxed-splits should be mellow but firm.

It is a great advantage to a cutter when a skin is shaved to a uniform substance, and when from any cause it is irregular the skin would be put into a lower class. The skin should be well-grown and well-waxed, but not over-stuffed with grease. The flanks should not be so loose that much has to be rejected.

Vegetable-tanned leathers finished on the grain-side, such as *glove-hide* and *grain-shoulders*, are very liable to be injured by being buffed too deeply; this causes them to be tender on the grain. Many East India kips finished as box-calf are badly marked with thorn scratches and scars from unfriendly horns; it is in endeavouring to remove these that the grain is often excessively buffed.

A feature of chrome-tanned side leather is that the offal—belly and flanks—is not as well filled as it would have been by the vegetable-tanned process; consequently the skins selected for this method of dressing should be well-grown. The face of the leather should be bright and not tender, and the pattern uniform in size, but it would not be so with a poorly grown skin; there should also be an absence of harshness.

Chrome-tanned glacé kid should be manufactured from well-grown skins, it being purchased according to surface measurement, and when there is a large amount of inferior material the good parts are thereby rendered more expensive.

Goat-skins vary considerably in strength of fibre and fineness of face, besides which the chroming process used by one maker does not produce as supple a leather as the method used by another. On some leather the face is beautifully prepared before glazing, the latter operation being so carefully performed that in wear the leather scarcely ever wholly loses the effects, whereas on other leather the gloss is only the result of a size which washes off with the first storm of rain, even if it survives the process of shoe manufacture.

Sheep-skins, like those of the goat, vary considerably, some being fine on the face, moderate in substance, and for sheep-skin strong in fibre, whereas others are coarsely grown and very tender; the strength of fibre must never be overlooked in judging its quality. The skin is strongest in those varieties where the wool is short and coarse, approaching the character of hair, whereas a heavy fleece is usually accompanied with an open-textured and tender skin.

157. A feature common to all skins is the direction of the stretch in its different parts; this can easily be remembered since it is always identical with that which would take place with the movements of the animal's body. For walking, the skin just behind the fore-legs, and that in front of the hind-legs, must be of such a character that it stretches readily in the direction in which the legs will be moved and also just as freely contracts; it will not, however, be necessary for the belly to stretch in this direction, but transversely, while in the neck we may expect to

find a tendency to stretch in two directions. It is also noticed that the *lines of tightness* are identical with the position and direction of the bony framework, hence we may expect to find the principal lines of tightness down the backbone and across the back as far as the ribs extend; also in the direction of the length of the shanks.

In studying this subject skins should be selected that have not been dried on frames, since in such cases much of the stretch may have been removed, and this may cause the skin to appear to stretch in a contrary direction; neither are skins useful for this purpose that have been puered and drenched.

Leather is sometimes described as being "tight in the direction in which the hair lies," and this may possibly be caused by it being the direction of the hair muscles.

Leather which has been split and "set out" does not show much tendency to stretch in one direction more than in another; possibly this is caused by the separation of the flesh-fibres from the grain-fibres, these being connected in such a way that while they are whole, the connections regulate the stretch.

158. Two methods of purchasing leather are in general use, one being by surface measurement and the other by weight; generally speaking, where the cost of production is proportionate to the substance of the material, the finished product is sold by weight—curried leathers, for example; and since the quantity of stuffing absorbed will largely depend upon its substance it may be argued that this is a very fair method of fixing its price; but although this may be admitted, it must also be conceded that the method easily lends itself to fraud, as the leather being porous may be over-loaded with fats and waxes which can be purchased at a less price per pound than that at which the finished leather would be sold. Stuffing[1] is said to increase the weight of the leather generally by about 10 per cent, but it may be done in such a way and with such materials that the increase is nearly 50 per cent. To detect this, carefully weigh a piece of leather, say about 2 inches square, shred it and soak it in ether for about twenty-four hours; the ether should then be filtered and evaporated, and from the weight of the residue approximate data may be obtained as to the amount of grease and wax which the leather contains.

159. Leather is often purchased by surface measurement; formerly this was done by judgment, the skins being sorted into sizes and the price *per* dozen regulated by the size and quality, but this is not now so general since with measuring machines the exact size can be so readily and accurately known; this method, however, also has its objections, since it often results in the skins not being so well trimmed, consequently there is often a larger proportion of inferior material. In the absence of a measuring machine the size may be approximately determined by first drawing straight lines around its edges, the uneven outline being averaged as in fig. 66; the area of the surface enclosed

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[1] Proctor, "Making of Leather," p. 126.

by these straight lines can then be ascertained by forming it into tri-

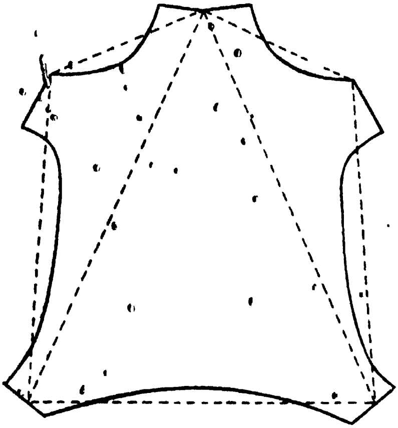

FIG. 66.

angles. To find the area of each triangle multiply half the base by its perpendicular height.

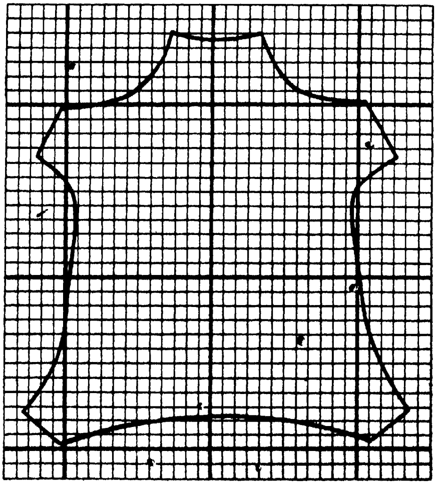

FIG. 67.

A readier method is to place the skin on a table previously marked up in squares—inches and feet; the skin can then be marked around and the area found by adding up the spaces enclosed as in fig. 67.

Skins can also be measured with long strips of card, each strip being 1 inch wide; it is then only necessary to count the square inches and divide by 144; this is the principle on which the usual measuring machines are constructed.

If it is desired to compare the relative values of leathers, the prices being quoted in different ways, then assuming that the material was similar in other respects it would only be necessary to estimate the values on a common basis, each being weighed, or each accurately measured; but if the leathers varied as regards the proportion of offal, then it would be necessary to compare the amount of prime material contained in a parcel of each, the parcels being equal in price.

CHAPTER XIII.

THE PRINCIPLES OF CLICKING.

160. BEFORE considering the laying out of the patterns, the strain should be considered which each part may have to bear during manufacture and in wear.

The principal strain in the process of manufacture is during the lasting, and the particular strain which affects the upper most is the heel-to-toe tension set up with the first tack. If a shoe is being lasted and one of the back quarters stretches in the direction of this strain, whereas the other quarter does not, then as a result the seams will be crooked; if both quarters in one shoe stretch, and the quarters in the other shoe do not, then one shoe will come much further forward on the last than the other, with the result that the caps will not be alike in depth.

If the vamp is cut with the stretch in the direction of the length, then it will be very difficult for the laster to set up effective heel-to-toe tension before he has exhausted the stretch of the material, by which time the vamp would have increased so much in length that the vamps would not match. If the vamp is cut with the stretch in a diagonal direction, then it will be almost impossible to keep the seams level; it should never be done unless both vamp and cap are machined to the lining, or otherwise supported.

When the toe-cap is cut with the stretch in the direction of the length, the laster will have great difficulty both in setting up the heel-to-toe tension and in lasting the toe.

The laster, however, is not the only one whose difficulties may be increased through the stretch being in the wrong direction; the machinist will also have her troubles; for example, if the quarters of a shoe stretch in the direction of the length, then it may be very difficult to make the covers and linings fit together unless an adhesive is used. It would also be difficult to machine a vamp cut from material that had much stretch (in any direction) unless it were held in position by an adhesive. If whole goloshes were cut with the stretch in the direction of the length there would be a similar difficulty.

In practice it is usual to cut the parts with the lines of tightness going from heel-to-toe, unless special precautions are taken to counteract the stretching; but sometimes to assist the machinist the method known as "tight seams" is adopted, the seams which would be most likely to stretch in the process of machining being then cut "tight," ignoring all other considerations; for example, the heel seam in a lace boot would be cut "tight," the stretch being placed in the heel-to-toe direction; the front seam of a button-boot would also be cut "tight"; and since the stretch around the top of a shoe would affect the production of the upper more than the stretch in the heel seam the same principle would apply.

The strain to which the different parts will be subjected in wear ought not to be overlooked, since it indicates where the best material should be placed; for example, the top edge of a shoe is subject to much strain in wear, and weakness might result in the shoe quickly losing its shape, whereas there is very little strain at the bottom edge which is lasted in, since in wear the material is supported with the stiffener; therefore the poorest part of the material in any shoe quarter should be placed there, and the best should be at the front end, especially if the vamps are cut from the same kind of material; otherwise the vamp being selected from prime material might by contrast make the quarter look poor, although the same material might not be too poor to use where it would be supported by the stiffening.

The vamps should always be out of the strongest of the material, since the constant flexing of the foot at the joint is a severe strain on the leather; furthermore, it is often subjected to considerable abrasive friction at the joints, and its edge where it meets the sole should be able to resist water-penetration, while if a toe-cap is to be used the cap and the adjoining part of the vamp should be similar in quality; if it is not possible to place the vamp so that all its parts are uniform in quality, the poorest part should be in the extreme end of the wing, and if "right and left" patterns are being used the poor part should be placed at the inside waist, since it would there be subject to the least strain. When the vamp is cut through and a toe-cap is also used, no evil could result from a small defect which would be covered by the cap.

Toe-caps should be cut from firm material, but as they do not get as much strain in wear as the vamps, they need not be as stout—unless it is for children's shoes; they also have the support of the toe-casing and do not get any flexing, unless the caps are very deep. The material should be firm since the strain during lasting generally stretches it and with tan goods this would result in the cap becoming lighter in colour.

The back quarters of boots—whether lace, button, or Derby—if they have a seam at the back, should not be placed so that just above the stiffener the material would be weak, because this part is subjected to a hinge action every time the foot is flexed, consequently it is always liable to break off through fatigue; neither should weak material be placed in that part of the quarters which comes next to the front of the vamp, since it might suffer by contrast with the vamp. At the top of the leg there is hardly any strain, and although the appearance of the boot might be affected if the material were inferior in quality, it is very improbable that the wear would be affected. Provided that the appearance was not prejudiced, no serious objection could be advanced against putting a thin place at that part of the back which is supported by the stiffener.

Button-pieces should be cut "tight" in the direction of the button hole, otherwise they might quickly lose their shape.

Tongues should be cut "tight" in the direction of their length because of the tendency for them to be stretched.

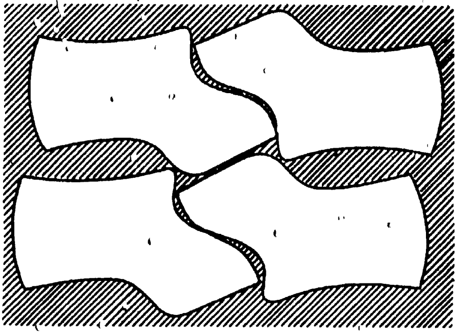

FIG. 68.

161. Before studying the actual disposition of the patterns on the leather, attention should be directed to the rules which facilitate economic cutting: it is often found that by placing the patterns in certain positions not only can they be cut with the minimum of waste, but the shape of

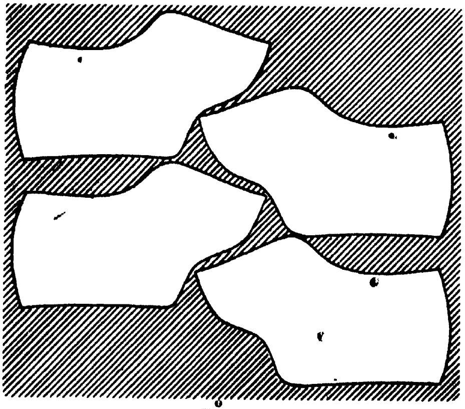

FIG. 69.

the material left is such that the same disposition of the patterns can be repeated, and when this is so the arrangement is termed a "system"; but while it is advisable that systems should be memorized, it is more important that the underlying principles be mastered; these may be summarized as follows:—

(*a*) Fit straight lines to straight lines.

(*b*) Fit curves to similar curves.

(*c*) Always aim to leave a straight line at the edge of the material.

(*d*) If two systems are equally economical but only one of them enables you to cut the work in pairs, then that one should be selected.

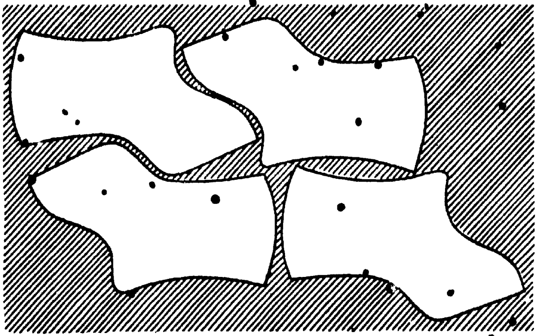

FIG. 70.

Fig. 68 illustrates a method of placing shoe quarters; its disadvantage is that they are all for one side, whereas by placing them as in fig. 69 they might have been cut in pairs. These systems, however, only lend themselves to patterns designed for shoes which carry a low heel; patterns for shoes carrying a high heel usually have a curved bottom line and the system shown in Fig. 70 is then more suitable.

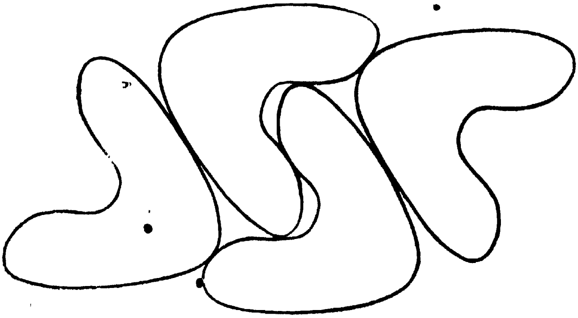

FIG. 71.

162. Vamps may be arranged by several systems; fig. 28 is for vamps without caps, the toe of one being fitted into the cue of another; it is best adapted to vamps that are cut for lasts with narrow toes, the wings being opened to assist the system.

Another method is shown in fig. 71, where the wing of one fits into the opening of another, but such as have the toes cut off may be placed as in figs. 27 or 29. Goloshes are not cut whole as often as formerly

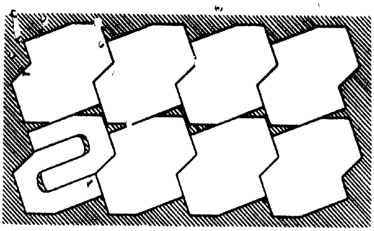

FIG. 72.

since the three-quarter golosh produces better results as to economy in cutting, ease in lasting, and comfort in wear; figs. 72 and 73 illustrate the usual systems.

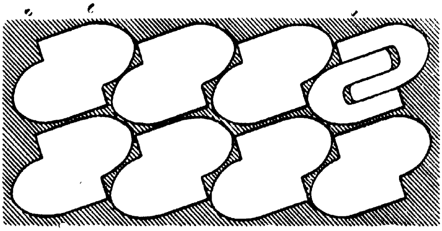

FIG. 73.

Legs for goloshed boots may be cut by the systems shown in figs. 74, 75, 76.

Leather, however, varies so much in substance, quality, and the direction of the stretch, that it is not possible to adhere strictly to either of the systems shown; there are therefore some general methods applicable to different kinds of leather and patterns.

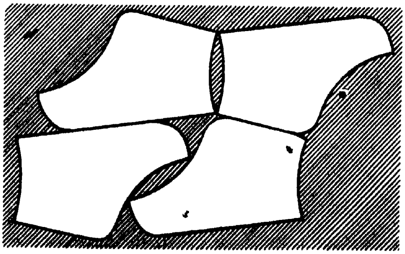

FIG. 74.

In cutting side leathers where vamps and legs have to be cut from the same material it is usual to take the vamps along the backbone as they need the best of the material (§ 160), but the number of rows which may be taken, and the distance along the back which the system may be continued, will depend upon the size of the pattern, the class or grade

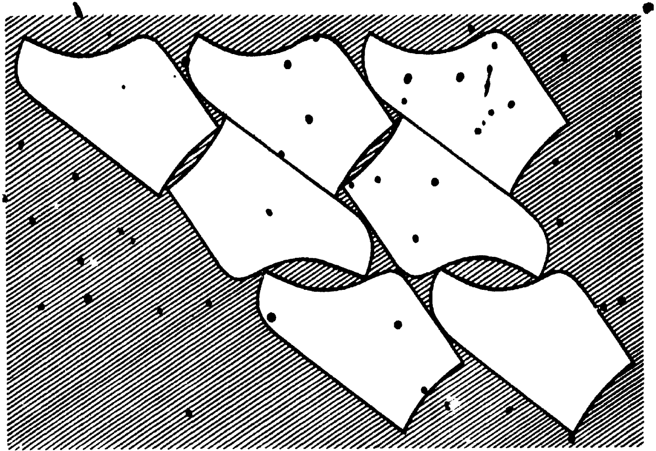

Fig. 75.

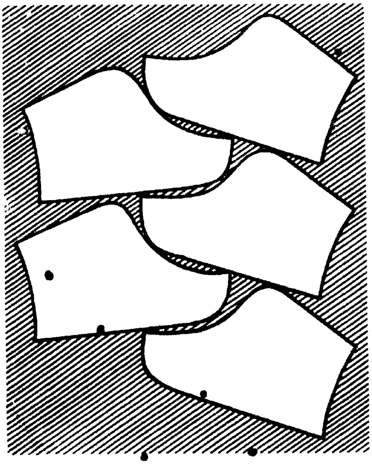

Fig. 76.

of work being cut, and the size and quality of the material; the latter will also have to be considered when deciding how far into the shoulder the system may be carried. On the same principle, in cutting a skin (which differs from a side in that it has not been slit down the backbone), the vamps would be cut from the same part of the material and the legs from the parts nearer the edges, the caps being cut from material similar in quality to the vamps, although they may be lighter in substance; the requirements of the different parts of the leg, moreover, should not be overlooked.

It is sometimes found that the arrangement of patterns used on one skin can also be used on other skins; when this is so it saves the cutter's time, but the same system could not be continually repeated unless the skins were uniform in size, quality, and substance, and free from defects, which would necessitate a special selection of leather; consequently such a method of cutting is not adopted except by factories making only one quality, and that a good one, in which case they adhere to the system for the centre of the skin and sell what is called the "skirtings," *i.e.* the edges; but both patterns and skins vary in size and the arrangement which may be suitable for one skin and set of conditions may require modification when a different size pattern or skin is used, otherwise the amount of waste would be disproportionately large.

If for any cause—whether it be the size of the skin, flaws, or other defects—it is not possible to follow the usual system, then an effort should be made to put the best parts of the material where the greatest strain will be, both in manufacture and in wear, the weaker parts being put where they will have the advantage of being supported either by the stiffener or toe-puff.

In the interests of economy, as much of the poorer part of the material should be used as is possible without impairing the appearance and utility of the boot, and this equally applies whether the work is being cut for quality or for quantity. True economy depends not only upon the number of pairs cut from a given quantity of material, but also on the value of that which is cut, and therefore economy may be effected by two means:—

(*a*) Careful arrangement of the patterns to minimize waste.

(*b*) Economy of the prime material in the most important part, using as much of the inferior material as possible where it does not impai the quality. It is the varying degrees of skill in the economy of the prime material that principally distinguish different workmen.

163. The utilization of the inferior parts of the leather is a very important problem, as is also the disposal of the light parts which may be in other respects of prime quality; the first refers more especially to box-calf and chrome-tanned sides, the second to glacé kid. Leather which has a pattern, whether printed or otherwise developed, if poor, may often be utilized by strengthening it with a good backing cloth, after which a satisfactory pattern can be obtained with the aid of a pebbling machine. When supported in this way the rules as to stretch need not be so strictly observed, and therefore it is not unusual to resort to this device when for purposes of economy it is deemed advisable

to ignore the correct direction of the lines of tightness. Glacé kid, having an excellent face and silky character is sometimes deficient in substance, but such leather can be supported with a specially prepared backing cloth, the material being then sometimes placed in a press heated by electricity which causes the rubber to adhere better. It is probable that in wear such leather would be quite satisfactory; since in any case when the face cracks the shoes are generally discarded; the pebbling already referred to could be done on the same machine by changing the top plate.

164. A clicker having received a quantity of leather would first sort the skins for size, substance, and quality. We will assume that the largest sizes have the stoutest material; but which should first be cut, the large or the small skins, the clear, good ones, or those that are either damaged or inferior? The advantages of the former are that these could then be cut strictly to a system, which should be advantageous both as regards economy of time and material, since it is quite conceivable that if left until the last when back-quarters must be cut for a particular side, the opportunities for economical cutting may be curtailed. But conceding this, it must not be overlooked that it is in proportion to the quality of the material that it will be less necessary to place the patterns in a particular position since there would be more uniformity in its quality, whereas in poor or damaged material often the patterns can—for economy of quality and of material—only be placed in one position, and if such a skin is left until the last, it is possible that a quarter for this side may not be required, hence the material cannot be used to the best advantage. In placing the patterns on damaged material, it may be found that a large pattern would just fit in, but if the large sizes have been already cut, then a smaller size must be used, but this is not economical cutting; obviously therefore, the greater the selection of patterns both as to size and shape, the greater will be the opportunities of economically using material which is too much damaged to be cut by a regular system; but if such leather is left until the last, there will then not be an opportunity to take these advantages, the selection of patterns being so much smaller.

165. Side leather is always commenced at the butt end of the backbone, but skins may be commenced in various ways; when cutting by the "selective" method it is usual to commence at the butt end of the backbone, but when the "exhaustive" method is used it is generally considered advantageous to use the hind shanks first; should the butt end of the skin be defective for any cause, and for the purpose required inferior to the material in the head, then the skin may with advantage often be commenced at this part. It must not be forgotten, however, that the pattern on printed leathers is often not uniform in size, generally being larger in the head, in which case the size of the grain should be similar in each pair, and *the direction of the print must not be ignored.*

166. There are two methods of cutting, the "exhaustive" and the "selective"; the latter is used for "bespoke" or "custom" shoes,

or for high class wholesale orders, and only the suitable portion is used, the remainder being passed to another workman or, more generally, being sold. It is not as economical as the exhaustive method—in which case the workman uses up the whole of the material—since by the former method the inferior parts might not always be of such size and shape that they could be used without considerable waste; but the varied qualities found in a skin cannot be used up in a single line of shoes if uniformity of quality is to be maintained; hence this method can only be used by those manufacturers who make a range of qualities, and to assist the cutter it is usual to supply him with a selection of patterns so that small ones can be used where it is not possible to use large ones economically, a cheap grade being cut where it is impracticable to do better.

There is also another variation in the methods employed, since while one manufacturer only cuts to ticket, another may cut principally to ticket, but also running in a stock line to make it possible to exhaust the material.

167. Before commencing to lay patterns upon fabrics it is advisable to consider the method of their manufacture. Two sets of threads are used, one being placed in the direction of the length of the material known as "*warp*" threads and kept strained during the weaving, whereas the shuttle thread—that is the one which crosses the warp threads—is not strained so tightly, and is known as the "*weft*," or "*woof*". The two threads are not usually equal either in size or strength, the shuttle thread often being both smaller and softer, to enable it with greater ease to be bent by the warp threads; sometimes it is made from cotton which has a shorter staple, and less tensile strength. There is very little stretch in the woven material if it is strained either in the direction of its length or its width, but the weft thread being usually the weaker, the tensile strength of the material is less in this direction. If strained diagonally the material will at on be distorted in shape, since in this direction there is nothing to offer resistance. These facts should form the basis of the principles to be observed in cutting fabrics; they indicate that neither linings nor covers should be cut with the heel-to-toe line running diagonally, since effective tension could not then be set up by the laster; but in addition to this it would result in the threads running diagonally across the joints, it being evident that then there would not be any restriction to the stretching of the shoe in width, therefore it would quickly lose its shape in wear; sometimes when there is very little difference in the strength of the weft and warp threads, it is permissible to let the heel-to-toe line be in the direction of the width of the material should economy in placing the patterns require it.

Until quite recently "cutting" was considered a hand operation, but the clicking machine is now rapidly supplanting manual labour, the advantages claimed being that:—

(*a*) The outlines are always true to shape, whereas with hand labour they often vary;

(*b*) The edges are always square, but with hand labour they are often oblique, especially with stout material;

(*c*) Workmen who are not skilful with the hand-knife can cut with the machine as accurately as more skilful men;

(*d*) There is an important saving of time, since it is impossible for the hand workman to cut as quickly as the machine.

Against the foregoing may be urged:—

(*a*) The cost of the machine and repairs;

(*b*) The cost of power;

(*c*) The cost of knives.

If, however, the probable life of the machine is considered, it will be evident that the expense spread over such a length of time would reduce the cost per week to a very small amount, while the cost of power would be also small, both sinking into insignificance when contrasted with the advantages. The cost of the knives may under some circumstances be a sufficient reason for not adopting the machine; for example, if on any pattern only a very small trade is probable, it may not be wise to incur the expense, but if 10,000 pairs would probably be needed then the outlay would be justifiable; it should also be remembered that even with hand-work the necessary patterns would have to be provided. The outlay for knives may, however, be considerably reduced by standardizing the patterns; the back-quarters of boots for a given height of heel could be standardized, and this would make it possible to use them for several lasts, even though a different vamp pattern may be desirable; it may also be possible to use the same vamp pattern for several sets of patterns only changing the quarter patterns, and there would be but little necessity for changing toe-cap patterns.

With fitting patterns such as quarter-linings for shoes, inside facings, vamp-linings, side-linings, and tongues, the same knives might be used for several years, that is assuming the goodwill and co-operation of the pattern designer.

CHAPTER XIV.

THE FITTING OF THE UPPERS.

68. For appearance, comfort, and strength, the edges of the different ections of the upper are generally reduced in thickness before being achined together, each of the various seams calling for special treatent as regards the shape, width, and depth of the scarf.

Closed seams—like the back seam—after skiving, are machined toether and then opened out flat; the scarf need not be wide or deep, ut it should make it easy to open out the work and to rub the seam own smoothly, without unduly straining the stitches; hard or harsh eather will require a wider and deeper scarf, but weak or soft material, hat would be compressed by the rubbing down, should not be skived ore than is necessary. Attention should be directed to two parts of he scarf:—

(*a*) The greatest thickness of the material which it is possible to eave just where the stitches are placed and yet have a seam that will ie flat when rubbed down—this varies with the different types of leather.

(*b*) The necessary thickness of the extreme edge to avoid its breaking ut with the stitching, since if it is too much reduced the machinist nust run further in from the edge, and this will increase the difficulty f rubbing down; it follows therefore that if much reduction is necesary the scarf should be either concave or wider, preferably the former. Vhen the material is such that the seam cannot be made to lie flat vithout reducing its substance so much that it is unduly weakened, then welt should be used, in which case the edges may be left stouter see § 76).

Lapped seams are used where it would be difficult to make the vork lie flat with a closed seam; they are stronger than the latter, and re used for attaching toe-caps, vamps, goloshes, etc. The piece which s to be on top and which will have a row of machining close to its edge, may be reduced, but not so much that its strength is impaired; the ature of the material, class of boot, and size of thread to be used must ach be considered, the width of scarf being such that a neat appearance s secured. The underneath piece (which is over-lapped) may be reluced at its edge considerably, seeing that the stitching will not be ear it; the primary object of the skiving in this case is comfort, and the width of the scarf will depend upon the substance of the material, and the laps allowed. The foregoing applies to all lapped seams (§ 71).

Edges that are to be left "raw" should be reduced as much as is consistent with strength, since it results in neatness and uniformity of appearance, thus avoiding the clumsiness of an unskived edge; they must not, however, be reduced too much, as this would result in weakness. Bagged edges should preferably be skived with a concave scarf, since the edge must be strong enough to hold the row of stitching, and at the distance from the edge where the material will be folded (when turned out after closing) the substance of the fold should not exceed that of the single material, since it is desirable that a heavy appearance should be avoided.

When the edge is to be turned in or beaded, its extremity will be reduced to a wafer, and at $\frac{3}{16}$ inch farther in it should equal only one-half of its full substance, otherwise the effect will be that of heaviness, instead of neatness.

Formerly skiving was done by hand, but now this is very rare, it being now performed by machinery of which there are three types in general use, each having its admirers. The knife in the "Amazeen" machine is a circular disc as in the "Marvel," but in the "Fortuna" it is cylindrical and rotates at right angles to the direction of the feed, which is from left to right. The feeding devices also differ, that of the "Amazeen" being a circular disc rotating in a plane parallel to the knife, whereas in the "Marvel" it is a conical wheel which rotates so that the plane of the knife is tangential to the feeding surface of the cone. On the "Fortuna" the feeding device is the convex surface of a wheel which has its axis at right angles to the axis of the knife; in this machine the pressure foot above the feeding device is changeable, a range of shapes being supplied with the machine, which differ as regards their concavity, corresponding more or less to the convexity of the feed-wheel, so that a scarf suitable in shape can always be obtained.

169. The folding of edges is much more general now than previously owing to the advent of modern skiving machines, but probably this is because the work can be done so much quicker and cheaper with folding machines. There are two distinct types in general use, the "Booth" and the "Boston" being types of one class in which a template is used, the whole of any outline, such as the curve of the vamp or front of the leg, being made to conform to the template instantly. No fault can be found with the work which the machine does, nor with the speed with which it is performed, the only objection being the necessity of procuring a different template for each outline.

The "Lufkin" and the "Rapid" belong to the second group; with these the outline to be folded is placed against a guide, the edge is then turned over by the machine, the feeding device carrying the work forward until in a similar way the whole of the outline is completed. In the "Lufkin" the action of the adhesive is facilitated by a regular "nicking" of the edge, but in the "Rapid" the corresponding device may be used or omitted at the discretion of the operator, since it can instantly be changed without stopping the machine.

With the process known as "bagging" some assistance is needed when turning out the work to secure a correct outline. When the tops of boots are cut straight the "Monarch" beader is a useful machine, the top of the boot being strained over the straight edge of a vertical steel plate, and while held in this position pressure is simultaneously applied at both sides by the smooth edges of two wheels. The machine is rapid and accurate results can be obtained even when the leather is inclined to stretch. If this machine cannot be employed the "Columbia" beader type is used, the upper being then folded over two upright plates facing the operator like two fingers; the one in front has an eccentric motion so that it moves in the form of an ellipse, while the one which is behind it only has an oscillating motion. With the assistance of these the outline is made true, and is afterwards passed underneath a machine hammer which is fixed a little above and behind the fingers.

170. Raw edges which would show in the finished boot (unless machine trimmed) should be inked previous to machining, since it can then be done quicker and better; less ink would also be required, and there would be less danger of it being smeared over the upper, in which case it might come off with subsequent handling thereby increasing the difficulty of keeping the work clean. With leather that is vegetable-tanned a black die similar to curriers' ink may be used, which produces a permanent stain, but ink which depends for its effect upon the presence of tannic acid in the leather is not suitable for chrome-tanned leather; quick-black (specially prepared) will then give better results since it dries with some polish and would not rub off with subsequent handling.

171. The adhesive used should be carefully selected; formerly paste made with either wheat or rye-flour was used, but the former is rarely met with now and the latter does not enjoy the same amount of favour as formerly, both having been largely superseded by rubber-solution. The disadvantage with rye-flour paste is that a considerable application of the thick paste was generally used, and this did not improve the upper since it dried in a hard cake that offered considerable resistance to the needle, besides which the softness and pliability of the upper was impaired; but when the paste is a few days old better results can be obtained, since the fermentation which takes place considerably increases its adhesiveness, the application of a smaller amount being then sufficient. Rubber-solution has one disadvantage—it is expensive, but being so adhesive only a very small amount need be applied, and even if a considerable quantity were used, it is so flexible that the pliability of the upper would not thereby be seriously affected; there is also the further advantage that it is not necessary to wait until the adhesive "sets" as with a flour-paste.

The relative merit of samples of rubber-cement is determined by the amount of work which can be done with a gallon, the price quoted being very little guide to its actual value.

The objections which are advanced against the use of adhesives are :—

(*a*) It is an extra operation which means more expense;

(*b*) The cost of the adhesive;

(*c*) The delay caused by the operation.

If, however, the validity of the objections is conceded, yet the advantages even then are considerable, since

(*a*) It is a safeguard against parts stretching during machining;

(*b*) It reduces to a minimum the probability of uppers being crooked or badly fitted;

(*c*) The machinist can do more work if she has not the responsibility of keeping the parts in position.

It is possible to reduce considerably the necessity for using adhesives by introducing patterns which have the closing seam allowances of fabrics always marked; prick-marks should also be used for facings, topbands, or other lapped seams.

Special machines can often with advantage be employed, since they render it unnecessary to lay the upper quite flat as is unavoidable in vamping on a flat-bed machine.

CHAPTER XV.

THREADS.

172. IN the manufacture of boots and shoes four materials are used for closing, sewing, and stitching, these being hemp, flax, cotton, and silk. Hemp and flax are "bast fibres," that is, the fibrous part of the stalks of plants.

Hemp is obtained from a plant (*Cannabis sativa*) which grows wild in the East Indies, but which is now cultivated in most of the temperate and tropical countries of the world. When the plants are from 5 to 6 feet high they are ready to be pulled up, the stalks being generally spread out in the fields until the action of the elements has caused the woody tissue and gums enclosing the fibres to decompose, this process being known as "retting"; the fibre must now be separated from the other portion of the stalks, after which it is thoroughly cleansed and spun into yarn.

Flax is the product of an annual plant (*Linum usitatissimum*) commonly known as the cornflower, having spear-shaped leaves and blue flowers, often growing wild in the cornfields and sandy pastures of our southern counties. The stems rise to a height of about 2 feet, and when the plants are nearly ripe they are either cut down or pulled up by the roots, after which they are subjected to a process known as "rippling," the plants being drawn through a machine which removes the seeds and leaves. Retting may be carried out in a similar manner to that used for hemp, or the stalks may be tied in bundles and placed in stagnant water; active fermentation soon takes place, resulting in the decomposition of the woody tissues which enclose the fibres, which after cleansing are spun into threads.

The cotton plant is a shrub which varies from 4 to 6 feet in height; it appears to thrive most readily in North and South America India and Egypt, being an annual plant, except in tropical climates where it becomes a perennial, and assumes more of a tree-like form The leaf of the cotton plant has three pointed lobes and the flowe five petals, which are yellow at the base but become almost white at the edges; the fruit of the plant forms the cotton "boll," which contains the seed with the attached fibres, and should be picked as soon as possible after ripening. The first process it undergoes is the separation of the seed from the fibres, which are then carded, roved, and made into yarns.

Silk is obtained from the cocoons spun by the "silk-worm," the larvæ or caterpillars of certain bombycid moths; the cocoon (or nest) is formed by the larva when about to change into the pupal state. The cocoons are thrown into hot water which kills the larvæ and softens the gummy substance that keeps the thread in position, which is then wound off on reels, the thread from several cocoons being formed into one thread, and many of these compound threads being afterwards put together, a certain amount of twist being given to cause the finished thread to have more solidity and strength.

There is considerable difference between the various fibres which have been mentioned; although hemp is difficult to distinguish microscopically from flax, yet it can be recognized by examining the ends of the fibres, since hemp often exhibits forked ends, whereas flax never displays this peculiarity; the former is not uniform in its diameter, there being occasional attachments of woody tissue and a jointed-like structure, whereas even under the microscope the surface of the flax fibre presents a smooth surface. Cotton, not being a bast fibre but "seed-hairs"—that is the fibre which is attached to the seed—is quite free from any joints or unevenness, there being only one cell in its entire length; hence it is the smoothest of the three fibres under consideration, and on account of its fineness and the number of twists which it has, much finer yarns can be spun from it than are possible with either hemp or flax; yarns being regularly spun from it so fine that 300 hanks each containing 840 yards, only weigh 1 lb. Flax, on account of its smoothness and hardness, cannot be spun into such fine yarns as cotton, hemp being still more difficult, because of the woody tissues which cling to the fibres.

Durability of the Fibres.—Of the three fibres under consideration hemp is the most durable; water does not rot it although it slowly dissolves in sulphuric acid. The fibre, however, is rather dark in colour, and cannot be successfully bleached without serious injury to its quality.

Flax will not stand the damp like hemp, and so great care is necessary in retting it since over-retted flax is brittle and weak. The fibre quickly dissolves in sulphuric acid, and is readily bleached, although it suffers considerable deterioration in the process, therefore the whiter it is bleached the weaker it becomes. Cotton withstands the damp better than flax; from experiments conducted by the Industrial Society at Mulhause it would appear that alternate moistening and drying on hot cylinders causes little or no deterioration in its strength. With reference to the bleaching of cotton Dr. Matthews says: "It may be safely concluded that the tensile strength of cotton yarn is not injured by careful though thorough bleaching". The result of experiments on the three fibres shows that given equal thicknesses of threads the relative strengths would be, Hemp 100; Cotton 83; Flax 78. Silk is also considerably affected by the bleaching and dyeing processes, experiments showing that although the tensile strength of number 16 yellow is 7½ lb., that of white in a similar size is 6 lb., whereas with black it is only 5 lb.

To estimate correctly the relative utility of the foregoing materials, it is advisable to bear in mind the differing purposes and circumstances under which they may be employed, whether they are for hand or machine use, and whether the primary consideration is appearance or strength.

For hand-work where utility is the principal consideration, hemp takes precedence because of its great tensile strength and ability to withstand decay by damp; hence it is used for sewing on welts, and even for stitching on the soles of boots where strength and durability are essential. It can be purchased in either green or brown, but the former not having been bleached is preferable. Hemp is not used on sewing machines on account of the difficulty of spinning a thread sufficiently smooth and uniform in thickness.

For hand-work where appearance is of importance flax is used, whether for the uppers or for the soles, the length of its fibre making it possible to attach the bristles neatly, even when the threads are very fine. It is the principal fibre employed in threads intended for use on bottoming machines, its smoothness and length making it possible to produce an even thread without much twist, whence it is very soft, and even with considerable tension does not cut into the leather as would a harsher thread. For upper closing, however, where a much finer thread is required, flax is not suitable, since the finished thread is not as even in thickness as a cotton thread of similar size, and with the growing popularity of the latter for upper closing flax may soon be displaced.

In the bottoming of boots and shoes, cotton has not up to the present been much used in England; for hand-work (where threads are made from the yarn by the workman) it is never used, this being impossible on account of the shortness of its staple or fibre, which is generally only about 1 inch long, and rarely exceeding 1½ inches.

According to some reports cotton thread is extensively employed in America, not only on sew-round machines but also on those used for welting, stitching, and McKay sewing, its chief advantages being softness, freedom from frays, and evenness. For upper closing cotton is now the principal material used, since it has claims to most of the essential features which in order of importance may be placed as follows:—

(*a*) *Its utility in the boot*; this will depend upon
(1) Its tensile strength;
(2) Its ability to withstand damp;
(3) The elasticity of the threads;
(4) Its ability to withstand fatigue.

As regards the first it is superior to flax, but the varieties of cotton are not uniform in the strength of their staple, and the yarns made from any one variety of cotton also vary because of the differing methods of spinning, the amount of twisting considerably affecting its tensile strength; but if two finished cotton threads of uniform size are tested, say No. 40, one being made up of three strands but the other of six, that which is made of six strands will prove to be the stronger. Much useful knowledge may be obtained if one examine the cottons of various makers, carefully untwist each, count the strands, and compare the strength of the thread. On the second point cotton is certainly superior to flax, and with reference to the third, since it is almost non-elastic, a tight seam can be made with relatively less tension than would be necessary with silk; hence the seam being tighter there will be less probability of free play between the parts, and this considerably affects the durability of the seam; but should there be any free play cotton will stand much better than silk since the tendency of the latter to cut off is well known.

(*b*) *Its adaptability to use in a machine* is secured by

(1) Uniformity in thickness;
(2) Smoothness;
(3) Ability to withstand abrasive friction;
(4) Softness;
(5) Absence of any tendency to curl.

Cotton thread, because of the twist in its staple, can be spun into very fine yarns—often as fine as No. 300—so that a No. 40 cotton may be made of three strands, each consisting of two threads; by using so many counts in a single thread it is possible to secure great evenness and smoothness, far exceeding that of linen thread; hence a needle with a smaller eye can be used since less friction will be set up by the passage of the thread, and a good cotton will not be appreciably affected with the unavoidable friction which does take place.

The softness of the cotton is important since it influences the tension required to strain up the stitch; with a soft cotton it is possible to use more stitches to an inch, there being less strain on the leather, hence with it leather can be machined which would be too tender for a hard cotton.

(*c*) *Its appearance.* Cotton is often described as having a "silk finish," this being striking evidence of the recognized superiority in appearance of the latter, the softness and lustre of which make it possible to secure a pearl-like stitch not otherwise obtainable. It may also be noticed how quickly coloured cottons soil, whereas the freshness of silk is not so easily sullied.

Cotton threads may have either a left or right-hand twist, the object being that the twist shall throw the loop toward the point of the shuttle and reduce the liability of stitches being missed. The left-hand twist is recommended for single-needle machines and for the right-hand needle of twin-needle machines, in other cases use the right-hand twist. It should not, however, be overlooked that threads are made of several strands—varying between two and nine—and that when being used the tendency to untwist will be most marked in threads having only a few strands—say three—but when six strands are used these would first be wound in pairs, the three pairs being afterwards wound in a direction opposite to that which had been used for the first operation, thus resulting in less tendency to untwist and they can therefore be used indiscriminately as regards the direction of twisting.

Utility of Silk.—Even though cost may not be important yet silk is not used on machines for both the top and bottom threads because of its great elasticity, a tighter seam resulting from the use of linen thread in the shuttle, and since the use of this is general it may be taken as evidence that the latter is sufficiently strong; for extra strong work, however, silk is not often employed, it being recognized that linen thread is then preferable; silk, in fact, is fast being superseded by cotton, the prejudice against which is rapidly disappearing, but for appearance silk is unrivalled.

Yarns are standardized by weight and length, the following system being used:—

Eight hundred and forty yards of cotton yarn make one hank; the number of hanks required to weigh 1 lb. being the number of the yarn; "No. 40, 3 cord," would signify that three strands of No. 40 yarn had been formed into one thread; but this system is not followed if either two, four, six, or nine cords are used, in which case the number signifies that the finished thread is of similar size and weight to the corresponding number in three-cord thread; for example, "No. 40, 3 cord" thread would be equivalent to a yarn of three times the size; therefore ⅓ of forty hanks, or 13⅓ hanks would weigh 1 lb.; this 13⅓ is approximately the standard for weight and length of threads having either two, four, six, or nine cords and this particular number—40.

For a "No. 40, 2 cord" the finished thread must be such that about 13⅓ hanks will weigh 1 lb.—as shown above; therefore each of the two cords must be of about 26⅔ hanks to the lb., the nearest convenient yarn to this being No. 28, which would be employed.

Similarly for "No. 40, 6 cord," each of the six cords must equal (6 × 13⅓) hanks to the lb., *i.e.* the number of the yarn for each cord must be about 80—in practice this number is used.

The same system applies to other sizes, the complete tables for which may be consulted in the "Cotton Spinner's Diary".

Since there are only 300 yards of flax yarn to a "lea" or "lay," and the number of leas to a pound coincides with the number of the yarn, it can be understood why there is so much difference in the number of cotton and linen threads of similar size.

Silk is numbered on the same principle, there being 1000 yards to a hank.

Hemp is numbered according to the weight of 14,400 yards, No. 9 signifying that this quantity weighed 9 lb., it may however be so coarse that the same length weighed 15 lb., this figure then being its number.

It may be noticed that in 1 lb. of hemp No. 9 there would be 1600 yards, since 1600 × 9 = 14,400; whereas 1 lb. of No. 9 flax would contain 2700 yards, since 300 × 9 = 2700.

CHAPTER XVI.

UPPER CLOSING MACHINES.

173. THE needles used in the closing of boot uppers have several important parts.

The gauge of the needle selected must be such that it makes a hole sufficiently large for the thread to pass through without undue friction, and in the case of a lockstitch, that the lock may be drawn into its correct position without unnecessary tension on the top thread. The particular gauge required will depend upon the thread which is being used and the material being machined, it being evident that the lock made with a soft silk could easily pass through a hole which would be too small for a hard finished cotton; in addition to which soft materials such as fabrics would not require as large a hole as would an enamelled leather. The hole made by the needle should be filled by the thread, but should not be so small that it injuriously affects the thread as the latter passes through the material.

Needles are numbered, but unfortunately there is neither uniformity between the different makers, nor in the needles used by one maker on all machines. In the book of instructions issued by Messrs. Singer & Co. for machine 29K, we find size 4 needle should be used for Nos. 16 to 24 cotton, but on machines of 21W class, No. 16 cotton requires size 7 needle, and in class 45W a size 8 needle. It is regrettable that a uniform gauge is not always used and the same standard employed by all makers.

The eye of the needle is very important, since through it the thread must pass many times before being fixed in a stitch; it should be as large as possible for the gauge of the needle, otherwise the thread will be injured by the friction caused in passing through the eye even when the hole made in the material is sufficiently large; it is also important that those should be selected which have a well-finished eye; when the length of service of each needle is considered, together with the small cost at which the best can be procured, and this is contrasted with the injury which may be caused to the thread by a needle of inferior finish, the policy of purchasing the latter seems unjustifiable.

The points of needles vary considerably in shape, those in general use for closing boot uppers being shown in fig. 77; (*a*) round point; (*b*) cross point; (*c*) reverse twist; (*d*) twist; (*e*) triangular; (*f*) wedge; but here again there is considerable confusion since they are not uniformly named by all the makers. When deciding which of these variations is most desirable, the choice may be dictated either by utility or the appearance of the stitch which is produced. When fabrics are being machined a round-pointed needle should be selected, otherwise the material would probably be weakened, through a number of the threads having been cut by the needle's knife-like point. The strength of a seam is destroyed when the loops of the stitch is severed, whence it follows that the stitch which is least exposed to injury has something in its favour, and the needle which secures most protection is the "cross" point (the cut made forming a cross with the needle's eye), since when the stitch is being formed the thread is pulled in the direction of the cuts made by the needle, this resulting in the stitch sinking into the material (fig. 77 *b*); it is, however, not so much in favour since fewer stitches must be used to an inch than with the leather point, although a larger thread can be employed without impairing the appearance since it is partly hidden.

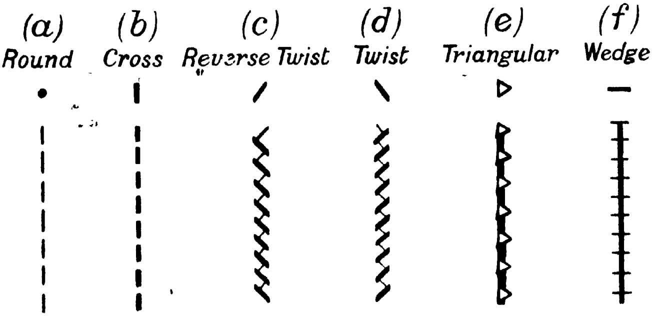

FIG. 77.

The "wedge"-point needle is not so much used as formerly, although with it a strong seam can be made, it being possible to use considerable tension without the stitch cutting the material; yet if two rows are used with little distance between them, the material would thereby be weakened more than it would have been with a "leather-point" needle, and in addition to this the stitch produced is not considered equal in appearance to that thrown by either the "leather" or "twist"-point needles.

Fig. 77 indicates the effect of each shape point on the appearance of the stitch; it will be seen that with *c* and *d* a larger number of stitches can be used to an inch, while for fabrics either *a* or *e* should be employed.

On some machines—as Singer's two-needle left-hand cylinder machine, 45W2—needles are used whose points are triangular in shape, the object being to enable the rows to be put nearer together, but many prefer the shape of the stitch which is obtained with "leather-point" needles.

The grooves. In addition to the foregoing there are two grooves in each needle, one being long and the other short; the object of these is to allow the thread to pass through the material with the minimum of friction, consequently the long groove should extend as far up the needle as will be necessary for it to penetrate the material; this is not the case on the side having the short groove—which is always the one nearest the shuttle—since, while it is necessary to reduce the friction to a minimum, yet there must be sufficient that when the needle commences to ascend, the thread on one side will by friction be held in the hole, the needle on that side ascending without it, thus causing the thread to form a loop which will be engaged by the stitch-making device.

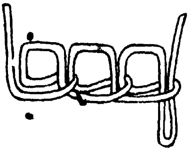

FIG. 78.

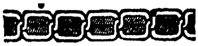

FIG. 79.

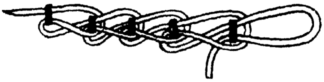

FIG. 80.

174. There are several types of stitches used in upper-closing machines; the chain-stitch illustrated in fig. 78 is formed with a single thread, the needle—which is always threaded from the long groove side—descends to the extreme of its motion and then commences to rise, but on the side of the needle that has the short groove (which side is always placed next to the stitch-forming device) the thread remains stationary in the material although the part of the thread which is in the eye of the needle rises with it, thus forming a loop which is held by the stitch-forming device until the needle again descends and passes through it, when another loop is formed.

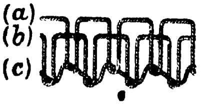

FIG. 81.

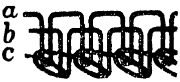

FIG. 82.

The lock-stitch is generally used for the closing of uppers since a tighter seam can be obtained; two threads are used, one above and another underneath; the complete stitch is illustrated in fig. 79.

The Union Special double lock-stitch (fig. 80) is said to produce a stronger seam than either of those mentioned, since if one stitch is cut across, those adjoining are not any weaker, as the "lock" of these stitches is not impaired, whereas with the chain stitch (fig. 78) should one be severed the adjoining stitches "run," or come undone.

When several rows of machining are placed at the same time, each may have its own stitch-forming device as in figs. 78 and 79, otherwise a single shuttle thread may be used, figs. 81 and 82 being examples; *a* and *b* are the top threads and *c* the shuttle thread; in fig. 82 the motion of the shuttle is circular.

175. For the consideration of the relative tensile strengths of seams produced with these various stitches, and also those in which cotton, silk, or silk and cotton, had been used, reference may be made to the summary of tests made for the Union Special Machine Company of Chicago, U.S.A., by J. E. Howard, the Government Expert, 3 August, 1894. Conditions in the tests were kept as constant as possible; two inches of seam being tested in each case and always sixteen stitches to an inch.

Stitch shown in figure.	1 1 Row No 24, 4 cord cotton	2 2 Rows No. 30, 4-cord cotton on top, No 20 3-cord below	3 1 Row D silk.	4 2 Rows C silk	5. 1 Row D silk on top; No. 16, 6-cord cotton underneath.	6 1 Row D silk on top; No. 30, 3-cord cotton underneath	7 2 Rows C silk on top; No. 16, 6-cord cotton below	8 2 Rows C silk on top; No 40, 3-cord cotton below
78	$145\frac{4}{8}$ lb.	277 lb.	$198\frac{1}{8}$ lb.	314 lb.	—	—	—	—
79	$131\frac{2}{8}$ lb.	219 lb.	—	—	$134\frac{3}{4}$ lb.	—	247 lb.	—
80	$161\frac{2}{8}$ lb.	300 lb.	—	—	—	$187\frac{4}{8}$ lb.	—	355 lb.

Assuming the correctness of the tests, then from columns 1 and 2 it is evident that the ordinary lock-stitch is not as strong as a chain-stitch, the Union Special being the strongest seam. It also appears that the more elastic a seam is, the greater is its strength, since it is admitted that the lock-stitch is the least elastic, and the test shows it to be the weakest; in addition to which there is the evidence from columns 1 and 3, that silk, which is so much more elastic than cotton, is by far the stronger. It should not be overlooked that when silk is used on the top and cotton thread used underneath, the strength of the seam is not appreciably improved by the silk. There are, however, two considerations which have caused the chain-stitch to be superseded by the lock-stitch, one being the tendency of the stitch to "run" should it be severed in any place, and the other, the great saving in the amount of silk required, when a shuttle thread of linen or cotton is used; added to the foregoing, in practice the lock-stitch is found to be sufficiently strong. For zig-zag stitches see §§ 177 and 178.

176. Stitch-forming mechanisms vary considerably in the machines of different makers. With the chain-stitch a device is necessary to take

the loop of slack thread which is thrown out when the needle commences to ascend, and hold it back while the work is fed forward, keeping the loop in such a position that the needle passes through it when descending to form the next stitch; each time the process is repeated a stitch is formed.

In lock-stitch machines it is necessary that the top and bottom threads cross, as in fig. 79; the loop thrown by the needle is similar in all machines, but the methods of locking differ. The underneath thread, which is wound on a spool and enclosed in a shuttle, may be shot through the loop; this type of shuttle has a reciprocating motion, but since the end of the shuttle must be pointed to permit it to enter the loop, and that only one end is pointed, it follows that after passing through the loop the shuttle must return to its original position before it can commence to make another stitch. This return journey, however, takes time, and since the shuttle is not then accomplishing anything, it is considered to be waste motion, therefore the method has been improved upon with the result that a larger number of stitches can be placed per minute.

Sometimes the spool or bobbin remains stationary while the case in which it is held rotates; such cases have a hook which enters the loop thrown by the needle, gives it a half twist and passes it over the bobbin, thus forming the lock

Rotary hooks are not always placed in the same position in the machine; they may rotate in a horizontal plane parallel with the bed of the machine, or in a vertical plane—at right angles to the bed—the bobbin case being then on its side, immediately below the needle. The name "vertical hook" does not mean that the hook is vertical, but that the shaft which gives motion to the hook is vertical, it being attached to the upper end of the shaft. It is not necessary that the hook should make a complete circle to form a stitch, consequently there are hooks which have an oscillating motion, and move backwards and forwards making a part of a circle each time; an example may be found in the Singer Company's Universal Arm Machine, 29K. When comparing machines as regards the stitch-forming devices, that one is considered best which requires the smallest loop to allow the shuttle to pass, since the thread will travel forward and backward through the eye of the needle a fewer number of times before it becomes part of a stitch, consequently there will be less wear on the thread.

177. *Feeding Devices.* To secure uniformity in the length of stitch some mechanical device is necessary which will move the work forward as each stitch is formed. The most common device is a wheel with a serrated edge, a portion of which engages the work that is immediately beneath the needle, and carries it forward as the wheel revolves; to vary the length of stitch the motion of the wheel is either increased or decreased. Often a "drop feed," or "four-motion feed," is employed; it first engages the work by pressing upward, then it moves forward taking the work the distance required for the next stitch; its third motion is to disengage itself from the work by dropping, and its fourth

motion is to return toward the operator ready to rise and engage the work again. A similar principle is employed in the pressure-foot of the Universal Arm Machine, 29K (Singer's), only in this machine the device is above the work instead of underneath; when a stitch has been formed the foot rises and steps forward, then descends and grips the work, next carrying it toward the needle that the stitch may be placed. The stitch known as "zig-zag" is produced by the needle bar having a reciprocating motion imparted to it so that it moves in a line transverse to the direction of the feed; a stitch is placed when the needle has reached the extreme of its motion in one direction, the next stitch being placed when the needle has travelled to the extreme of its motion in the other direction, the work being fed forward between the stitches; this motion in some machines can be employed or dispensed with at the instant wish of the operator.

178. Closely associated with the foregoing is the "pressure-foot," whose primary object is to keep the work against the feeding device and thus ensure uniformity in the length of the stitch, but it also serves other useful purposes since it prevents the work being pulled out of position by the needle when it is being withdrawn upwards from the work; it also presses the sections closely together making it possible to obtain a tight seam without unnecessary strain on the thread, while not the least useful purpose is that it indicates just where the needle will descend for the next stitch, thus making it possible with the minimum of skill to keep a true line. The oldest form is probably that in which a section at the end of the perpendicular pressure-rod is bent and opened so that it presents a small flat surface which is parallel with the bed of the machine. The pressure used—which is always adjustable—should not be more than just sufficient, otherwise the friction set up by its broad base will tend to stretch the material. This type of foot is better for long straight seams than for sharp curves; hence while it is often used on lining-making machines, it is seldom employed on vamping machines, the contact surface being too large to enable the work to be readily moved. The disadvantages of this pressure-foot are not present in the "pressure-wheel," which consists of a small bevel-edged wheel, attached to the side of the bottom end of the pressure-rod in such a position that in addition to serving the useful purposes of the feed described above, it revolves as the work is fed forward and by so doing reduces the friction to a minimum. They are not made to a standard either as regards width of edge or diameter, it being usual to select a smaller foot when the curves are very sharp. Considerable assistance is also given by imparting to the pressure-rod a vibratory motion so that when the work is being held by the needle—after it has descended through the work—the pressure-foot rising makes it possible to swing the work as much as may be required without the length of the next stitch being affected; before the needle rises the foot again descends, the motion being repeated for each stitch. This vibratory motion of the pressure-foot may be used with any style of foot and with any kind of feeding device.

Reference has been made (§ 177) to the Universal Arm Machine in which the feeding device and pressure-foot are combined; it should also be noticed that this device can be turned round causing the work to be fed toward the needle from any direction; the machine is used for patching the uppers of worn boots and for sewing the bottoms on felt-soled slippers.

179. There is yet another important detail in which machines vary, *viz.* the shape of the bed or table; formerly these were always made flat, but with the development of the "held-together" system of closing, special machines have been devised which preclude the necessity of making the unfinished upper lie flat when being machined; the "post" machine has a very small table about 3½ inches by 2 inches, and this surmounts a post which is often about 7 inches high: the machine may be used for many purposes.

Many machines have a cylindrical arm, whose length is not uniform on all machines; it sometimes projects toward the right hand, at other times toward the left, the former being used for vamping while the latter is often used for under-trimming machines.

180. The work of machining has been greatly facilitated by the introduction of machines which will place a number of rows at the same time; two-needle machines may be seen in any shoe factory, and three, four, or eight-needle machines may often be seen in some districts which make special classes of work.

181. Between the top spool and the eye of the needle the thread-controlling devices are placed, the principal ones being the "tension" and the "take-up"; the thread first passes to the "tension," which usually consists of two convex discs so placed that the convex sides face each other; these are kept in contact by an adjustable tension spring, by which means the required amount of friction may be set up when the thread passes between the discs. Reference has been made (§ 176) to the amount of thread required to form a loop large enough to pass over the bobbin; to enable the stitch to be strained into position after the bobbin or shuttle has passed through the loop this thread (now slack) must be pulled up, and if stitches are to be placed quickly, the thread must be pulled up rapidly; hence a lever of the first order is used and the fulcrum placed very close to where the power is applied (Appendix I.); there is therefore a loss of power but a great gain in time, since the long end of the lever—through which the thread passes—is moved a much greater distance than the short end where the power is applied; the lever drops as the needle descends and rises soon after the needle, the length of the take-up lever varying, with the amount of loop required, on different machines.

The take-up lever always takes up the same amount of slack, but since some portions of the work may be stouter than others, and in the light parts less thread may be required, to ensure that the same amount of tension is used for each stitch, a take-up spring is employed and it should be suitably adjusted to balance with the tension.

182. Not the least important consideration is the speed at which the

various machines should be run; the longer the stitch the quicker will the work travel, and the greater will be the difficulty of guiding it; therefore it is the ease or difficulty of guiding the work that must ultimately determine the speed at which the operator can run the machine. Work cannot always be guided at the same speed; for example, it would be unreasonable to expect an operator to work as quickly when putting on whole cut vamps or goloshes as when machining down the backs of linings, since the curves of the former are so much more difficult than those of the latter, and the loss which would result from a slight inaccuracy, although negligible in the lining, may be considerable in the vamp; it is safe, however, to lay down the principle that the machine should be speeded so that the operator can guide the work while the machine is running, rather than that it should be necessary to stop the machine frequently, to see if the work is correctly placed. Opinion varies on this point, but where tests have been made the results have proved that excessive speed makes it more difficult to do perfect work, and also makes it difficult to accomplish as much work as with a more suitable speed. In addition to the foregoing there is *the effect on the work which is done*, for if the tensions on the top and bottom threads are adjusted so that with a given speed they produce a perfect stitch, then the increasing or decreasing of the speed will cause it to be defective. This is very noticeable on machines using a rotary hook, because in this case the bobbin being stationary the tension on this thread is constant, but so much slack is required on the top thread to form a loop which will pass over the bobbin that if much time is allowed while the tension is suspended between the stitches the shuttle thread may then appear as a straight line, the lock being formed on the back of the material instead of where it should be, but with the same tensions and excessive speed the loop may be pulled to the surface.

CHAPTER XVII.

STITCHING THE PARTS TOGETHER.

103. BEFORE commencing to put the various sections together the principles involved should be considered.

(*a*) Whenever possible the sections should be machined together at such a time that the work can be laid flat, because there would then be less probability of error; for example, caps should be machined to vamps before the latter are attached to the quarters, since after this operation it is often difficult to place the vamp flat on the machine; it would therefore require more skill and could not be so expeditiously performed.

(*b*) The various sections should be machined together at a stage where succeeding operations will not be made unnecessarily difficult; for example, in wave golosh work, the golosh might be attached to the legs before the backs are closed, and indeed it would be easier to do it at this stage, but afterwards it would be much more difficult to close the legs so that the goloshes would meet correctly at the back, especially when the work is not cut with "tight seams".

(*c*) There is also another reason why this method of attaching the golosh should not be adopted since it violates an important principle, *viz.* that the sections should be put together in the best order to secure strength. If the goloshes are first attached to the legs, then in closing the back there will be four thicknesses where the golosh laps the leg, and the difficulty of opening out and rubbing down the back seam will be an unnecessary strain on the thread; the stitches would probably be exposed, and in wear such seams would quickly give way; it is therefore considered advisable to close the goloshes down the back, and likewise the legs, after which the golosh is machined to the leg; when this method is adopted more care is required in attaching the golosh to the leg, otherwise the seams of the golosh and leg may not coincide, but the junction of these seams will then be both neater and stronger.

(*d*) Sometimes an operation may be performed at any of several stages during the production of the upper, without going contrary to any of the principles named; under such circumstances, the operation should be performed where—in addition to the foregoing—it is the best for appearance. The facing line affords an illustration, since it may be placed either before the legs are closed together, after this operation, or not until the lining and leg are attached; in practice it is now usual to select the first method since it avoids the unsightly appearance of the shuttle thread showing on the lining; when paste-fitting was usual the third method was often used, the inside facing being then cut sufficiently large that it was caught by the stitching of the facing, any excess being afterwards trimmed off. When legs are unlined and an inside facing is used, the facing must be caught by the facing line of stitching. There are many operations which must follow in a particular order unless appearance is to be sacrificed; for example, a lace boot may have a brown inside back-leather and facings but a black topband, in which case the topband must be placed all round the top of the leg; it would be easy to machine this along after closing the back of the linings, but it would afterwards be impossible to secure a neat appearance where the facings and back leather meet the top band; therefore it is necessary that they should be machined to the linings before the topband, and that the latter should slightly lap over the former.

184. There are three typical methods of closing the uppers:—

(*a*) Paste-fitting on the flat;

(*b*) Paste-fitting on the round;

(*c*) "Held-together" method.

With the first method the sections are kept in position by an adhesive (see § 171), but the partly made upper, instead of assuming the shape which it is intended that it shall be, is laid on a flat slab during the fitting operation; there can of course be no objection to toe-caps being fitted to vamps by this method, and when shoes have a fancy golosh which extends to the top this may be attached to the insertion on the same principle, but if the outsides are fitted to the lining by this method it often results in the linings being too full; this can be demonstrated with a strip of fairly stout leather and a piece of lining; place the strip of leather over the lining—keeping both quite flat—and machine the leather to the lining at each end; if this strip is now bent, as the top of the boot would be, it will be seen that the lining is too full, which shows that the flat method of fitting is not advisable for the legs of boots.

When work is fitted on the "round," a block is used somewhat similar in shape to a boot-tree, or last with a leg attached, and if the lining is placed on this, the outsides being afterwards fixed to it with an adhesive, then, even though the lining pattern may not be perfect, yet a smooth-fitting lining is almost certain, and even the fitting of whole goloshes is comparatively simple if done by this method; consequently it is still adhered to for high-class work where cost is comparatively unimportant. The arguments against the system are summarized in § 171.

185. The most popular method is that known as the "held-together" system; as its name suggests, all adhesives are discarded, the parts being held in position while being machined; it must be conceded that many parts of the upper can be put together this way quite as successfully as though they were fixed with an adhesive; for example, facings, topbands, and caps to vamps, but many firms making a good

class of work have now resorted to the slower, more expensive, but safer method of securing vamps and whole goloshes with an adhesive, since experience proves that this is cheaper than saving the cost of fitting but losing in consequence a larger sum through shoes having crooked vamps. The success of the system, however, depends upon the correctness of the patterns coupled with a sufficient number of guide marks; the machinist can only be held responsible for using these guides, and if the work is then not satisfactory the conclusion would be that the pattern required correcting; therefore the pattern cutter should endeavour to banish the probability of error by always having the lap allowance marked, and even the closing allowance for fabrics, it being obvious that if the pattern cutter with his trained eye does not trust to his eye when adding the seaming allowance, but uses a gauge, then a less trained machinist working at high speed cannot be expected to take the correct amount every time if no assistance is given; for the same reason the position of facings and topbands should always be indicated. With the best of patterns, however, it must be granted that it requires a more skilful machinist when parts are only held together, and some operations have proved to be so difficult that special machines have been designed, and with these satisfactory work is more probable since the parts—such as vamps and goloshes—can be machined without distorting the shape of the upper which would be unavoidable on a flat-bed machine. The system, however, is more suitable for some materials than others; leathers that are firm and which do not stretch with the friction of the pressure-foot being much easier to handle than those of a limp character, in which case the correct shape is only retained with great difficulty and by the exercise of considerable skill. When it is intended to use this method of machining the pattern should preferably be of plain design; slight inaccuracies would show badly with sharp curves, whereas with less pronounced outlines the defect would probably be unnoticed. (For the advantages see § 171.)

186. With work that is fitted on the block it is usual to machine through the lining when stitching on the vamps, but work that is not fixed with an adhesive and is also vamped on a flat-bed machine often has the linings too tight, it being exceedingly difficult for the machinist to determine whether the lining has kept in place or changed its position during the arranging of the upper on the machine ready for vamping; therefore to avoid the risk of such a defect work is often vamped "off the lining," the latter being folded back so that it is not caught by the stitching; it is, however, necessary to slit the facing in a direction parallel to the front of the leg, to enable the lining to be turned back at the place where the tongue is fixed in. Uppers that are machined in this way having "loose linings" are more difficult to last if the outsides are cut from material which has a strong tendency to stretch, since there is less restriction to stretching; consequently it is more difficult to set up an effective heel-to-toe tension, and in the finished boot the lining does not give the support which it would if it were machined to the outsides. The best argument (which, indeed, is

but a poor one) that can be advanced in favour of the method is, that if the linings are either badly cut or badly fitted, the defect is not so noticeable as it would be if vamped on the lining.

187. In the early processes of closing lace boot uppers the order would be as follows: After the preparation of parts (§ 168), facings would be stitched on and the linings joined at the backs by one of the methods referred to in § 75; for each style a special machine is used, where necessary guides are fitted for the edges of the linings and also for the tape, whence less skill is required than at first might appear necessary. The topbands are next attached either with plain or fancy stitching.[1] While the linings are being prepared, other workers will have been preparing the covers, skiving (§ 168), folding (§ 169), inking edges (§ 170), fancy punching, and stitching caps to vamps, using for the latter either a two or three-needle machine since it saves time and ensures accuracy. The legs should have the facing line marked—if this was not done at the time of cutting, which it may be, since cutting dies are often so designed (see fig. 83), and when the facing stay is fixed (fig. 84) they may be stitched, using either a single or two-needle machine, the latter being very effective when the impression desired is that of strength. The backs should next be closed, preferably on a machine having a vertical knife attachment, since this would trim off everything beyond the stitching which exceeded the fixed allowance; it thus ensures the seam being in the correct condition for the success of the subsequent operations of "rubbing down" and "silking"; the former operation is performed over an iron rest curved somewhat like the back of the leg, the rubbing being performed with the aid of an iron rod having a universal joint at one end. If the seam is first damped it facilitates the operation, better results being then obtainable. The silking should be done on a special two-needle machine having a foot with a guide which travels in the groove formed by the junction of the two backs and a device for holding and guiding the tape which is by the silking fastened on the under side.

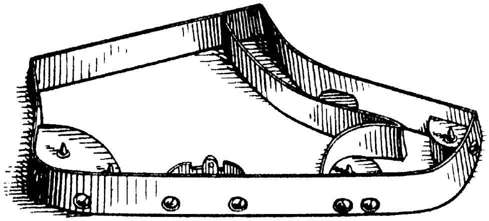
FIG. 83.

The details of the remaining operations will be varied according to the method of closing and style of upper. If the covers have a folded edge then there will be a raw-edge leather facing and topband; the lining should preferably be placed on the block, and an adhesive having been applied to the margin of the covers, they should be fitted over the lining—if the adhesive is omitted the work will have to be held in position. The folded edge of the upper should now be stitched round using a machine with an under-trimming knife attachment set at an angle of 45°, which will trim off the excess of the facing and topband which projects beyond the folded edge, and by trimming at so great an angle the greatest possible neatness is obtained.

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[1] If a coloured silk or cotton topband is used the leather facing is generally carried to the top of the leg, in which case the order of processes would be: (*a*) closing the backs of the linings; (*b*) fixing the topbands; (*c*) attaching the facings.

If, however, the upper has a turned-in front and bagged top, then without using an adhesive the face of the lining will be placed in contact

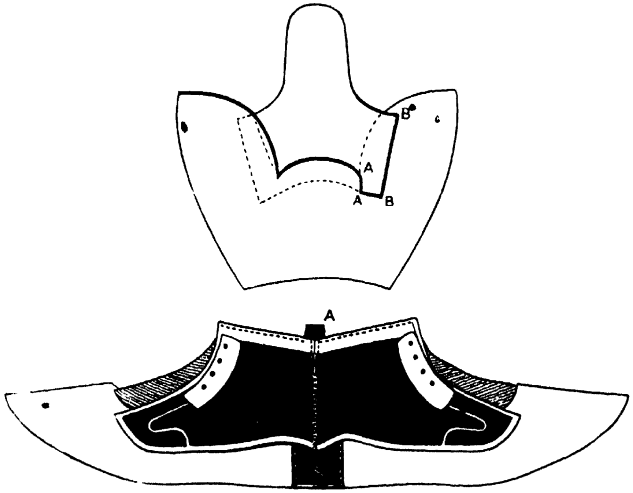

Fig. 84.

with the face of the outsides and the top of the leg be machined along (fig. 84); when this has been done the upper will be turned so that the face of the leather will be outside. If the top of the upper is cut straight it will go to the "Monarch" beader (§ 169), and afterwards be ready to be stitched round as already described.

The lining from the bottom of the quarters to the toe should now be closed and opened out flat, after which the quarters should have a bar, or stay, put across just above where the edge of the vamp will come. A zig-zag machine may be used for this purpose if the feed is thrown out of action, otherwise special machines are supplied for the operation. The object of the stay is twofold, since it draws the two sides of the upper close together and thus makes vamping easier, added to which it reduces the probability of the vamp breaking when the last is either slipped after making, or reinserted for channel closing. Sometimes the bar is dispensed with and a fold of tape placed between the vamp and the quarters, at other times an oval-shaped piece of leather is used, the latter being usual in the cheaper qualities of men's work; some manufacturers, instead of putting a stay, wait until after the boot is vamped and then put a short row of machining not on the vamp but close to its edge, thus fastening the tongue to the quarters. The vamp may now be fitted in position, first folding it to mark the centre of the opening or front curve which must be put where the quarters meet; the vamp may be kept in position with an adhesive or it may be held while it is being machined, the former being preferable. A cylinder machine should be used for this operation (§ 185)—and preferably a two-needle machine.

188. In the machining of the button boot the order of processes would vary from the foregoing; supposing the top is to be bagged and the button-piece folded, the following method may be adopted; the button-piece having been folded is fitted to the button-piece lining, the button holes may now be worked, after which the button-piece—not the lining—may be closed on to the inside quarter, then opened out and rubbed down but not silked; the backs may now be closed and silked, button-stays fixed and buttons put on; while this has been proceeding the backs of the linings will have been closed and topbands put on; the upper is now ready to be machined along the top and opened out as described for the lace boot; then putting the lining smooth in the back of the boot, silk the front seam so that the edge of the linen lining is lapped over by the edge of the leather button-piece lining, both being kept in position by the silking. The edge of the linen lining by the buttons must now be folded in and then the entire edge may be machined round, after which the toe of the lining must be joined and the button-piece then fastened in position with a bar just above the vamp position, after which the vamp can be attached.

Sometimes instead of the foregoing, the button-piece lining is attached to the linen lining and the button-piece attached to the quarters; this method does not make such a smooth front seam and the linings are often less satisfactory, while in addition it is not so expeditious, since the button holes cannot be worked at such an early stage.

189. In the closing of men's boots the same general principles apply, although it is usual to have an inside leather strap at the heel-seam of the lining; topbands and facings would be attached according to the principles already stated. In the closing of the backs there will be some variation, since if these are to have an outside back-strap to the top, the seam may be made as in § 76 (3) or (4). When a jockey back-strap is used, the backs may be machined on the "Straight-Away Zig-zag" machine, the part which will not be covered with the straps being done with an ordinary closing seam, but the other part is stitched edge-to-edge with a zig-zag stitch, the change being made without stopping the

machine (fig. 84). Another difference is that the hooks may next be put in, the reason for doing it at this stage being that they will not show on the inside facing. It is usual to insert loops in men's boots, and if the uppers are to be bagged at the top, the loops must be caught with the top row of machining as in fig. 84, "A" being the bottom of the loop; this must be allowed to come below as in the illustration so that it may be strengthened with some further rows of stitching. The subsequent processes are similar to those for a lady's lace boot, until the upper is ready for the joining of the lining at the toe; if the golosh is the style shown in fig. 27, the backs will first be closed and stitched—unless they are welted—and when they are attached to the legs, the toe of the lining will be joined, tongues put in, and vamps put on. When the golosh is either cut whole or three-quarters whole, and whether it has a jockey back-strap or not, the seams will be closed and silked, the golosh being then machined on, using a post machine for preference, and also an adhesive.

190. Men's counter-lined Derbys with outside back-straps and half watertight tongue go through different processes. After the preparation of the parts, the backs may be machined in style 3 (§ 76); the side linings are next joined to the counters after which they will be machined to the outsides; this is done from the inside of the upper so that it is the shuttle-thread which appears on the outside, consequently a lock-stitch is always used and care taken that the top tension is sufficiently tight that the shuttle-thread (on the outside) does not appear as a straight line. The tongues are now stitched to the vamp, the latter being generally put on top; the lap must be sufficient for strength (especially at the corners), after which the tongue must be slit as at AA, fig. 84, so that it can be turned up and attached to the quarters; a better method is to put the tongue on top of the vamp since there is then greater probability of the corners being watertight. The facings can now be machined on, and in so doing the sides of the tongue BB, fig. 84, must also be caught under the facing, after which arrange the fold of the tongue by the vamp, and place the tab of one of the quarters to the guide-mark on the vamp; it is then ready for machining; the other side can now be similarly fitted. It will be noticed that on one side the machining must be commenced at the tab, but on the other side at the edge of the vamp, because the pressure-foot must rest on the quarters.

191. Ladies' shoes require other processes. Those which are to be turned in round the top should, after skiving, be closed at the backs before folding, otherwise the seam will have a clumsy appearance; the marking of facings will be the same as in boots. Since the covers are folded there will be a leather lining (which will be raw edge) with probably a linen vamp lining (see § 83); the quarter linings will be closed, opened, and rubbed down, after which they can be machined to the outsides using the under-trimming machine. Having put the bar across, the vamp lining can be attached, placing it between the quarter and the quarter lining, and working with the pressure-foot

on the inside of the shoe, so that the stitching can be placed on the edge of the leather lining; the latter will have to be slit near the front of the shoe, as the row of closing will make it impossible to slip the vamp lining between the quarter and quarter lining; this, however, will be covered by the tongue, which can now be conveniently fastened in; the vamping will be as for a boot. When shoe quarter linings are cut so short that it is not possible to join the vamp linings to them after the quarters and quarter linings are stitched together, it is necessary to join the linen linings to the leather quarter linings before stitching the latter to the outsides, in which case a seam down the front of the vamp lining cannot be avoided.

192. When shoes are bagged (§ 169) the shaping of the edge will be effected with the "Columbia" beading-machine, but apart from this the order of processes will be as for other shoes of similar design.

Whole-cut shoes are referred to in § 88; the method of machining will be dependent upon the style of the shoe at the top; if the cover is beaded with an overlaid raw-edged facing, then the order of processes may be as follows: after skiving, close and silk the backs, then bead the top line; the lining is now closed and fitted into the covers, after which this portion of the top of the shoe may be machined, and when the inside and outside facings are fitted to the shoe they also can be stitched.

An order of processes similar to the foregoing may be used if the shoe is bagged from A to B, fig. 44, in which case if the facings are not fixed by an adhesive, it may be found convenient to machine the front line of the facing—from D to F, fig. 44—before attempting to attach it to the shoe, as it would keep the inside facing in its correct position. Sometimes, however (when the facings are of suitable material), they are both machined at the commencement, the outside-facing to the cover, and the inside-facing to the lining; the back of each may now be closed, then the lining and cover stitched round the top, turned out on the bagging machine, and the top edge receive its final row of stitching. A cylinder machine is most suitable for the last operation, and therefore when this has to be done on a flat-bed machine it is not unusual to change the method; the facings having been attached as in the former description, the lining and cover would be stitched round the top except about 1 inch on either side of the back; the portion stitched round would now be turned out on the bagging machine, and receive its final row of stitching, after which the heel-seam of the lining and also that of the outsides would be closed and the bagging of the top completed.

The principle of the method just described is often used for Court shoes, and is the only method of machining Cambridge shoes—such as have no seam down the front and with an elastic gusset on either side.

If the principles which are involved in the designs referred to above are mastered, little difficulty should be experienced with uppers of any regular design.

CHAPTER XVIII.

BOTTOMING LEATHERS.

193. THE leathers used in the bottoming of boots and shoes are described by the general term "sole-leather," in contradistinction to "upper-leathers".

Sole-leather is obtained principally from "beef-hides," but pig-skin and camel-hides are also used, and sometimes horse-hides. The term "hides" is applied to the skins of the larger full-grown animals of the bovine or ox group, and also to the skin of the horse and the camel, but the skins of the smaller Indian animals of the bovine class, even when full-grown, are called "kips".

194. Hides which are intended for sole-leather are generally received by the tanner in one of the following conditions:—

"Green" or market hides are such as reach the tanner soon enough after the animal is slaughtered that treatment to prevent putrefaction is unnecessary.

"Dried" or "Flint-hides" come from Buenos Ayres, Monte Video, River Plate, Cape of Good Hope, or China They are generally dried in the sun, being suspended from stakes by the head and tail, with the hair outside, but a better method would be to hang them with the flesh outside in a shady place where there is a good draught of air. They must be thoroughly dried, otherwise they would putrefy, consequently they become very hard—hence the term "flint-hides". Sometimes the great heat dries the surface so quickly that the moisture cannot escape from the interior, the result being a decomposition of the centre of its substance; when such hides are tanned and cut up the leather is sometimes seen to be in two separate layers, the middle of its section having been destroyed. Common salt is used in the Chicago stock-yards for what is known as "packer-hides"; any large pieces of adhering fat are first trimmed off, together with the thin layer of voluntary muscle which is spread over the flesh-side of the hide of the horse and the ox, used for twitching to drive off the flies; the hide is then spread out flat and an amount of common salt, not less than 25 per cent of the weight of the hide, is thrown over the flesh-side after which it is folded in half, the fold being at the backbone and the flesh-side inwards; the shanks are also folded inwards to keep them in contact with the salt. If carefully salted, hides may be kept in this state for twelve months or longer. It is said to be the most satisfactory method of curing now in use.

Drysalting is a method frequently used, and in preventing putrefaction it is satisfactory. After having been trimmed the hides are hung in a cool room where there is a good draught of air, and are partly dried; they are afterwards spread out on the floor and covered with salt, which, being hygroscopic, draws a considerable amount of moisture from the hide. When the salt has extracted sufficient moisture to form a brine, the hide is drained and suspended until it is in a *rubbery* condition; it is then re-salted and finally dried.

195. In selecting the hides much care is required. When commencing to skin an animal, a cut is made along the belly, and then, pulling back the skin with the left hand, the tissue holding it to the body is cut through. After the edge of the hide has been flayed the animal is hung head downwards, and the remainder of the hide flayed by pulling and beating. If at the commencement the flaying is not very carefully executed, the hide may be considerably damaged by the butcher's knife. These cuts are not at right angles to the surface of the hide but slant downwards towards the backbone, and are often 6 inches long, the length of the cuts being in the same direction as the backbone; they are sometimes so numerous and so deep that the value of the leather is reduced to about half of what it would otherwise have been. Mr. W. E. Walker of Bolton has estimated the national loss through bad flaying at £250,000 *annually* ("Tanners' Year Book," 1909, p. 77). Fortunately these cuts are avoided in the better part of the hide by pulling and beating it off, instead of cutting it away.

196. *Branding.* In Texas and South America cattle are reared in vast numbers on the unfenced plains, and since the owners could not distinguish their own cattle from those of their neighbours it is a common practice to have a monogram made in iron, and once a year to examine the herds for the purpose of branding all the young animals. The iron monogram is heated and a scar burnt in the hide near the hip-bone. The brand-marks vary in size, often being 8 inches square. When an animal is sold, its new owner puts his brand upon it, and under such circumstances hides sometimes have several brand-marks. Branded hides are classed as seconds, since the leather produced will be less valuable, the brand being always in the best part. The Chairman of the Leather Section of the London Chamber of Commerce estimates Australia's loss alone by fire-branding at £1,500,000 annually ("Leather World," 4 Dec. 1913).

In the United States, to avoid the necessity of branding, fences made of barbed wire are now employed; unfortunately many hides get damaged by it, for although the wounds may quickly heal, and not lessen the wearing qualities of a sole, yet the marks are difficult to conceal with the ordinary sole finishes. The scars are generally on the back of the animal, the part which yields the best leather.

197. *Warble holes* often lessen the value of a hide. These are caused by the maggot or larva of the "Warble-fly," or "Bot-fly" (*Hypoderma bovis*). The fly deposits its eggs singly over the backs of the fattest of the cattle. When the egg hatches, the larva eats its way

into the skin, inflammation results, and the insect feeds on the matte which accumulates. As the larva increases in size the wound als increases, until the larva, being fully grown, eats its way out and falls t the ground, where it changes to a *pupa* and in about thirty days th fly emerges. The holes generally penetrate the hide completely, th leather being then useless for any purpose where it is necessary that i be airtight or waterproof. As a rule the holes are about the size o small peas, but they are sometimes as large as filbert nuts, and a singl hide has been known to contain nearly 700. Sometimes the animal i slaughtered before the grub is full-grown; the damage will not then b as great, but would still be sufficient to affect seriously the finish of sole. Mr. C. E. Parker in the "Leather Trades Year Book" for 191 estimates the annual loss through this pest at £2,000,000.

198. Sometimes, about the neck and shoulders of the hide, there ar places which are more or less oval in shape, where the hide has undergone considerable thickening.

These places are attributed to blows, or to the effects of friction should the animal have been used for draught purposes. The specime before me is 2½ inches long and 2 inches wide. A swelling of the hid took place while the animal was alive, and in the process of tanning th hide-substance which had collected in the swelling was acted upon b the tannic acid and it became insoluble. These places are very hard and so brittle that under the press knife they are not cut, but broken.

199. *Hair-slipping.* If (before being specially treated) it is possibl to pull out the hair with the thumb and fingers, it is a serious defect since it indicates that putrefaction has already commenced, and i would be difficult to estimate to what extent the hide may be damage before it would be stopped. The effect on the leather would be tha the grain, instead of being smooth, would be marked with little hollow called "pin-marks," or "pitted grain". A similar effect may b caused by using lime which is very weak and which has been kept to long, or by putrefaction during the process of softening dry or drysalte hides.

200. *Growth of the Hide.* Apart from the defects named hide vary in value according to the relative weight of the shoulders and bell to the butt, since the leather made from the shoulders and belly is les valuable than that made from the butt. Bull-hides are heavy both i the shoulders and belly, whereas the butt is relatively lighter; cow-hide are thin in the shoulders and belly but stouter in the butt, while ox hides are the most uniform in substance and quality.

There is also considerable difference in the hides of the differen breeds; Scotch cattle as a rule have heavier hides than those reared i the south of England, and are not so fine in fibre.

201. The first operation in the tanyard is the preparation of th hides for depilation or unhairing. Green, or fresh hides, must b soaked for a few hours and then be cleansed from blood and dirt, afte which the flesh-side should be cleared of fat and voluntary muscle, th operation being termed "green-fleshing".

Fresh salted hides which have not long been in the salt will already have been cleansed, but they cannot be tanned while the salt is still in them; they will therefore require from 24 to 48 hours soaking according to the time they were in the salt, and the season of the year, less soaking being necessary in warm weather.

Drysalted and flint-hides are more difficult to soften, and, after being soaked for two days, they are generally subjected to a process of bending to assist the penetration of the moisture. One of the machines used for this purpose, called the *stocks*, consists of two heavy pieces of wood, raised alternately by projections on a revolving wheel, and allowed to fall on the hide which is placed in a box below.

In softening the hides much care is needed, for if they are soaked too long, putrefaction may set in, and the hyaline layer may be destroyed, while sometimes it causes dark spots with rings of a darker colour; this defect is known as *stippen*, and is caused by a species of bacteria, which, however, cannot live in lime; hence these marks are not found on leather made from green-hides that were limed for depilation.

The use of caustic soda, sodium sulphide, or sulphurous acid renders mechanical softening almost unnecessary.

202. When the hides have been cleaned and are in a similar condition to *fresh* hide, they are ready for the process of unhairing, which consists in removing the hair and that portion of the skin which is above the hyaline layer (§ 109).

There are many methods by which the hide may be prepared for unhairing, yet they may be grouped under two headings, *viz.* by *chemical action*, and by *putrefactive fermentation*.

The most popular agent used in the first group is *lime*. The hides are subjected to the action of *milk of lime*, obtained by slaking quicklime (*calcium oxide*) in water. It is usual to have in the yard several pits sufficiently large that the hides can be spread out flat; these are filled with lime liquors of varying strengths, and the hides are worked up the yard from one pit to another, until the hair can be pulled out with the thumb and fingers.

The time taken will vary from seven days to three months according to the weight and condition of the hide, together with the strength and age of the lime. The chemical action of the lime is of a solvent nature; the hair is not much affected, except the soft parts of the root and bulb; the hard cells of the epidermis, however, swell up and become soft; the young cells in the *rete mucosum* are more easily affected and are dissolved, together with the hair-sheaths, so that all that part of the skin which is above the hyaline layer can easily be pushed off with a blunt tool.

The dermis is also powerfully affected. The fibres absorb much water and this causes them to swell, thus increasing the substance of the hide and changing its condition from being limp and flaccid to one of firmness. The cementing substance which binds the fibres together is dissolved, and the fibres are thus separated into their elementary fibrils. The fibres themselves, however, are not damaged by proper liming, but if old stale limes are used, and the hides allowed to remain a long time soaking, then the ammonia which naturally develops in such liquors together with the bacteria which thrive under such conditions may do considerable damage to the hide-fibre, causing the leather to be loose, hollow, and dull-grained; it therefore should not be used for sole-leather where weight and firmness are of primary importance.

Strong liquors unhair quickly, swell the hide to its fullest extent, and also give greater weight in the finished leather.[1] The effect of lime on the fat contained in the middle fibres of the hide is to turn it into a soap which is insoluble in water. This soap is not injurious to the after processes of tanning or to the finished leather. In sweated or very low-limed hides this fat is a formidable evil, causing darkening or grease spots on the finished leather.

The fatty and fleshy matters on the under portion of the skin are also more easily separable by the fleshing knife after hides have been limed.

203. *Sweating process.* The principle of this process is to induce putrefaction. The part of the hide which first yields is the soft mucous layer called *rete mucosum*, and as soon as this loses its power to hold the external layer of the *epidermis* to the hyaline layer, then all that is above the latter can be removed with the unhairing knife. The usual method is to hang the hides in a closed chamber called a "sweat pit". It may be built above the ground or be partially sunk below it, but the part which is above the ground must be protected from sudden changes of temperature either by double walls or with banks of earth. The floor is perforated so that when necessary steam can be used to increase the temperature, or should it be too warm the air is cooled with sprinklers, so arranged that the water does not fall on the hides. The temperature should be between 15° and 20° C.

Little ventilation—if any—is allowed, because the ammonia given off by the decomposing matter facilitates the loosening of the hair and the solution of the epidermis.

After from four to six days the hair can be pulled out with the thumb and fingers, but the hide will be in a slimy, flaccid, and fallen condition; and as the process is so rapid, much vigilance is required, for if the hides remain a few hours too long, then in addition the grain is likely to be damaged. To avoid these two evils the hides when nearly ready for unhairing are put into lime pits to cleanse them from the slime and make them firmer to handle. The sweating process does not split up the bundles of fibres in the *dermis*, nor does it swell the hide whence it will be necessary to do this with acids after unhairing.

In contrasting the two methods Prof. Proctor says:—[2]

"Its (sweated process) most advantageous use is for sole-leather, as, although the solution of the hide-substance may not be very much less than in the case of liming, the dissolved matter remains in the hide instead of being washed out, and being fixed by the tannin, contributes to the solidity of the leather."

The other methods of unhairing are not so much used; for these the reader is referred to the works dealing exclusively with leather manufacture.

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[1] Proctor, "Principles of Leather Manufacture," p. 126.

[2] *Op. cit.* p. 120.

204. The mechanical operation of removing the hair and epidermis from the hide is quite simple; the workman stands behind what is called a *beam*—a convex table, fixed in a sloping position, and generally made from a sheet of iron—on which the hide is placed with the tail part towards the workman, who pushes off the hair with a double-handled tool having a dull edge, called an *unhairing knife*. The pushing is done in the opposite direction to that in which the hair lies; sometimes, however, the hides are unhaired by machine.

205. When the hair has been removed, the "pelts"—the name given to unhaired hides or skins—are put into soft water until the fleshers are ready to handle them. The fleshing operation consists in removing from the back of the hide all loose flesh, fat, or anything which was not removed at the green-fleshing and which would not be useful in the finished leather. It is not at all unusual for the tanner to leave more than he ought on the back of the pelt, especially on the belly part (§ 238), and since leather is bought by weight, this should not be overlooked when purchasing.

The work is performed with a fleshing-knife which is a double-handled tool having one of its edges suitable for cutting what cannot be removed with its dull edge, the operation being performed on the unhairing beam. Considerable care is necessary because the pelt, being soft, is easily cut, and owing to the convexity of the beam there is a risk of cutting long strips from the pelt; at the Leicester Municipal Technical School, for example, there is a Singapore side which, in many places, has been reduced by one-third of its substance at the deepest part of the cut. Specimens of English bends damaged in fleshing are unfortunately not difficult to find, although the defect is less common than formerly.

Fleshing can be done by machinery, but this is not usual with sole-leather, as the pressure of the machine reduces the substance of the hide and it is not easy to "plump" it again.

206. Hides which have been limed are, after the fleshing, sometimes subjected to a process of "deliming," the object being to neutralize with a weak acid any lime which may be on the surface of the hide. Formerly for sole-leather this was omitted, since tanners contented themselves with washing the pelt and relied on the natural sourness or acidity of the tanning liquors to neutralize the lime.

When the pelts are delimed with an acid bath, lactic acid may be used; this is one of the natural constituents of sour tan liquors and is said to produce better results than any other known agent, although boric, acetic, formic, and sulphuric acids are also sometimes employed. Lime, if left on the surface, will cause leather to be brittle on the grain (*pars papillaris*) and also to be dark in colour.

It is unfortunate that the term "grain" is used to denote three distinct things: (1) the Hyaline layer; (2) *pars papillaris*; (3) the pattern on the surface of the leather as "pebble grain".

207. When fleshed and delimed the pelts are ready for "scudding," *i.e.* the removal of lime-soap, small hairs, and the pigmented cells of the hair-sheaths, from the surface of the pelt. It is performed in a similar way to unhairing and with a tool similar to the unhairing-knife, except that it has keener edges.

For harness, belting, or upper-leather, where flexibility is important, processes now follow which are omitted when making sole-leather, since weight and firmness are more important.

When the sweating process is used for depilation, the substance which cements the fibres together does not get dissolved, neither do the fibres swell up, and the hide is not "raised". Under these circumstances the pelts after fleshing must go through special treatment to bring about these results. The method consists in putting the pelts into a bath of liquor to which acid—generally sulphuric—has been added; it has the disadvantage that it is liable to make the leather brittle on the grain and weaker in fibre.

208. The illustration (fig. 85) shows the shape of an average hide. They vary in width and length according to the breed and condition of the animal.

In America and Australia the hides before going into the tanning liquors are cut down the backbone, after which they are called "sides". This (as far as sole-leather is concerned) does not make the leather less valuable, while, on the other hand, it offers two advantages to the tanner, since it enables him to separate the branded from the unbranded sides, and, besides this, the stock is not so difficult to handle.

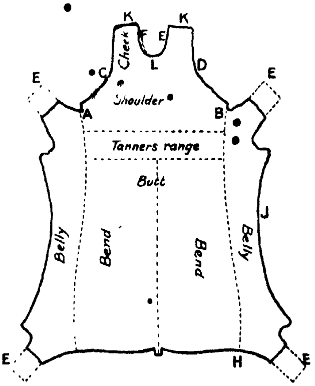

FIG. 85.

In England it is usual to cut the hide into sections just before putting it into the tanning liquors; a low table is used which is sufficiently large that the pelt can be fully spread out, the edges being then trimmed and the rugged pieces set aside for making glue. A pattern is used as a guide when separating the belly from the back; the tail part is then shaped, and the shoulders cut off. There is no fixed amount included either in the shoulder or the belly, the tanner being guided by the weight and quality of the particular pelt, and the demand of the market. When the shoulders are light and too poor to make good sole-leather, more will be cut from the butt, which would then be described as "short cut". Sometimes also, the growth marks in the shoulder are very pronounced and this may influence in deciding the amount to be included in the shoulder. When they are inclined to be very large a strip about 12 inches wide may be cut from the shoulder end of the butt, this being described as a "tanner's range"; but it would not be cut until the butt was tanned.

When the tanning agent to be used is such that the leather produced will not be very flexible on the grain, then the butt is cut down the backbone and each piece is called a "bend" (fig. 85).

The advantages of cutting the pelt into sections are:—

(*a*) That the poorer parts which do not take so long to tan can be finished off and put on the market in as short a time as possible;

(*b*) Suitable tanning agents can then be selected and used for the different sections; for example, the bend may be tanned for hard wear, the belly may be left flexible, the shoulders may be dressed for welting;

(*c*) Less expensive tanning agents can be used for those sections where colour and water resisting power are not so important.

In America, Australia, and Singapore, the tanning agents used are cheap and rapid; therefore as far as these two points are concerned little would be gained, but the greater suitability of the leather which could be obtained by tanning it in sections is apparently ignored.

The average proportion in the weight of the different sections has been given as follows: 50 per cent butt; 24 per cent shoulder; and 26 per cent belly. The shape of the hide at the shanks is very variable, some butchers and tanners leaving them very long as is indicated by the dotted lines at E, fig. 85.

209. Before discussing the method of using the tanning agent, the general objects of the process should be considered; it has already been remarked that raw hides quickly putrefy, and this tendency must be checked if the leather is to be suitable for use.

Raw hide becomes sodden if subjected to moisture, and would then quickly wear away; it must therefore be one of the aims of the tanner to make leather that is not bibulous and that would not become soft when exposed to damp.

It is also desirable that the leather be sufficiently flexible that the shoe can be bent by the foot when walking.

In endeavouring to achieve these objects three things take place:—

(*a*) The cementing substance which bound the fibres together in bundles and which is now in a saturated state between the fibres, is acted upon by the tannic acid which instantly changes its character so that it cannot afterwards be dissolved by water; it becomes "tanno-gelatine," a substance to which reference will frequently be made. The white fibres of the skin—which as we have already remarked (§ 111) are similar in nature to gelatine, being convertible into it by boiling—are also changed by the tannic acid, so that they become insoluble, but the yellow fibres are not much affected.

(*b*) A physical change also takes place, for the fibres attract to themselves some of the tanning agent—and by it they become more or less coated.

(*c*) In the later processes of tanning a gummy sediment is deposited in the body of the leather, thus more completely filling the spaces between the fibres.

210. Tannic acid can be obtained from many sources, but in some instances the acid is present in too small a quantity to be commercially useful. The various leathers produced by the different tanning agents possess distinctive features, and those agents which produce the best results as regards quality and remuneration to the tanner gradually increase in popularity while the others decrease in demand.

211. *Oak bark* is obtained principally from English-grown oak, that from Sussex and Hampshire being especially esteemed. The bark from trees less than thirty years of age yields a larger percentage of tannin than that of older trees.

When oak bark alone is used, the colour of the product is mottled fawn; it is the most flexible of sole-leather, does not attract the moisture like many leathers, neither does it become hard through being repeatedly wetted, but the time taken to tan with it is so long that the price of the leather per pound is higher than that produced by any other agent. For any style of manufacture it is considered an ideal leather, unless the boots are to be used for hard wear under damp conditions, since it would then grind away quickly, nor is it the most suitable leather for soles when hob-nails are to be used, since when saturated it is too soft.

212. *Valonia* is obtained from the beard or the ragged outside coating of the cup of the acorn from a certain oak (*Quercus ægilops*), which grows principally in Turkey, the Greek Archipelago, and Palestine, the best coming from the Smyrna district of Asia Minor. When exported the cups sometimes contain the acorns, although they are useless to the tanners; generally, however, the cups are exported free from acorns, but even this involves unnecessary freight expense, since only the beard contains tannic acid; therefore it is often stripped from the cups and placed on the market as "beard valonia".

In tanning, valonia is never used alone, since it is so astringent that the leather produced would be too hard and rigid, but when it is employed in conjunction with oak-bark the effect is to produce a leather browner in colour and less flexible than with oak-bark alone, according to the quantity of valonia used. Such leather when wetted is much firmer than if it had been tanned with pure oak bark; consequently for hard wear under damp conditions it is more suitable, but it is not sufficiently flexible for sewrounds, neither is it suitable for welted work where many stitches to an inch would be used. The price per pound is generally a little less than for oak bark, but the leather is so dense that it is not really cheaper.

213. *Mimosa* is grown in Australia and South Africa, especially in Natal, and therefore is often described as "Natal bark". It is obtained from various species of *acacia*—often called *wattle*—one of which (*Acacia decurrens*) with its yellow flowers, like balls of down, is used in the winter months for decoration, and is too well known to require further description. The bark, which is the part used in tanning,

is very hard, and is generally chopped or ground before exportation. The leather produced by this tanning agent is only slightly pink in colour, but on exposure to the sunlight soon becomes darker, inclining to red; it is flexible but not well filled, and rapidly absorbs moisture and then becomes very soft, therefore for outsoles it is only suitable for light wear, and for goods that are to be worn only under dry conditions. The leather is cheap because the tanning agent is not expensive and the time required to use it is comparatively short, being only about three months.

214. *Hemlock.* The hemlock-fir (*Abies* or *Tsuga canadensis*) grows in abundance in Canada, and in the Northern and North-Western States of America. Formerly only the bark was used, but now the wood is also employed. To save the expense of transport the necessary appliances are taken to the forest, so that when the trees have been felled the extract can be obtained at once, in which form it is supplied to the tanners. Both the bark and the wood contain so much resin that the extract cannot be dissolved unless heated to 65° C. In the process of tanning some of this resin is deposited in the leather, and without doubt tends to make it both rigid and waterproof, but the wood does not contain as much resin as the bark, and leather tanned with hemlock extract is not as rigid or waterproof as that tanned with the bark only. Leather, however, that is tanned with the extract alone will resist water for a long time, and does not even then become soft like mimosa-tanned leather, whence it is more suitable for hard wear under damp conditions, but it is not of much use for turnshoes or soles where a channel is required, because the difficulty experienced in turning back the lip would necessitate cutting such a large channel.

The colour of the leather produced is red, but much of the extract is bleached before it is used, and when this is not done the leather is often bleached in the process of finishing (§ 233), so that the hemlock-tanned leather of to-day is not as dark in colour as that which once was on the market.

215. *Quebracho.* The *Loxopteryngium Lorentzii* is a tree which grows in Central America. The name *Quebracho* is a Portuguese word meaning "axe-breaker," and aptly describes the extreme density and hardness of the wood. It is said that two Quebracho logs weighing one ton each will yield 1200 pounds of an extract that will tan as much leather as the bark from five acres of hemlock timber. The extract may or may not be bleached before it reaches the tanner; if it is used without being bleached the colour of the leather is reddish. It produces a soft leather which quickly absorbs water, hence it is used principally in the tanning of offal, as shoulders, cheeks, and faces; it is often used in conjunction with hemlock, and the leather thus produced is much easier to work than pure hemlock tannage.

216. *Mangrove* (*Rhizophora Mangle*), and other allied species, grow in swamps in most of the tropical parts of the world. An extract in dry crystalline form is made from the leaves and bark, and has become very popular among tanners, being used in combination with either hemlock, oak, or mimosa.

Mangrove produces a leather brighter in colour than hemlock, very dense and rigid, which does not readily absorb water and when saturated does not become soft. It is not mellow enough for any work which requires a channel, and cannot be used for turn-shoes, while its use for out-soles is restricted to riveted work. Singapore sides are tanned with mangrove.

217. *Chestnut*, or *Rock Oak* (*Quercus prinus*). From this is obtained the most important of the oak barks used for tanning in the United States, and also the "chestnut oak" extract of commerce. The tree grows in abundance in the Alleghany Mountains which extend along the eastern side of the North American Continent and through a part of the Dominion of Canada. In tanning it is generally used in conjunction with hemlock or quebracho to make "*union*" leather; this varies in colour, ranging from nut-brown to pink, according to the proportions of the tanning agents, and the method of finishing adopted by the tanner. The effect of the oak bark is to reduce the pronounced red colour of the hemlock, and to make the leather more mellow, while it also lessens its power to resist water. Union leather when wet is much softer than hemlock, it can be channelled easily, and is often used for sewrounds.

218. *Myrobalans* or *Myrabolams* are the unripe fruit of various species of Indian *Terminalia*. The fruit is similar in size, shape and colour to small green plums, the stones being large and hard; when soaked the fleshy part of the dried fruit swells up to its original size, and is the only part useful to the tanner. Myrobalans are only used in conjunction with other tanning agents, principally to modify the colour, as they yield a considerable quantity of bloom, and therefore if used in the latter stages of tanning should give weight and solidity.

219. *Sumach* (*Rhus coriaria*) is a shrubby bush whose leaves and small twigs are generally ground to a fine powder before exportation; the best quality comes from the districts of Palermo in Sicily. Sumach is not used for tanning bottoming leathers, but it is often used for bleaching them (§ 236).

220. *Divi-divi* (*Cæsalpinia coriaria*), a tree which in Central America and India grows to between 20 and 30 feet high; the part used in tanning is the dried pods, which give a firm heavy leather of a dark colour but which is very liable to fermentation; in dry weather the leather is firm, while in damp weather it is soft, therefore it is not much used for sole leather in England, although its use is on the increase in Germany.

221. *Spanish Chestnut* (*Castanea vesca*). This well-known tree grows abundantly in Spain, Italy and the South of France; the wood and bark are used for making an extract which is often called "oak wood" extract; it is said to give a moderately firm leather with an abundance of bloom and a reddish colour, but this will depend upon whether the extract has been bleached. It is used largely in England in combination with other tanning agents, but does not appear ever to be used alone.

CHAPTER XIX.

USING THE TANNING AGENT.

222. THE action of tannic acid seems almost instantaneous;[1] immediately the acid comes into contact with the gelatine of the pelt it converts it into tanno-gelatine. The following considerations will show why it takes so long to make the leather, in spite of the action being instantaneous. When a pelt is put into the tan pit, only the outside of it comes into contact with the liquor, this part is at once tanned, but the tanned part now forms a barrier which this liquor cannot penetrate, therefore liquor must be used which is strong enough to penetrate this wall and tan a further portion of the substance of the pelt. This method must be repeated many times—how many will depend upon the tanning agent used and the substance of the pelt—until it is tanned through.

223. Leather which is tanned in sides varies greatly both in substance and texture, some parts being thin, others stout; in some places its texture is open, in other parts it is close; the result is that some parts will be penetrated by the liquors before the stouter parts are tanned through. The pelts should remain in the pits until even the stoutest parts are thoroughly tanned, but tanners do not always wait for this. Specimens of partly tanned leather are not uncommon, and can easily be recognized by examining the section, the untanned portion, not being coloured by the tanning agent, will appear like a thin layer of horn in the centre of the substance of the leather; should there be any uncertainty, cut a thin section, dip it in water and hold it to the light; the untanned portion, which is really raw hide, will be translucent, but the tanned portion will be opaque.

224. In using the tanning agent a number of pits are required, with liquors of varying strength, so that the last pit will contain the strongest liquor; when the pelts are taken from this the liquor will have lost some of its strength, but it will probably be strong enough for the last pit but one; after it has been used for another batch of pelts the liquor, which has now become still weaker, will be utilized for a further batch of pelts, but in the pit which is last but two. In this way the liquors are worked down the yard until they become too weak to be of any service.

The methods adopted in the different tan-yards are similar in this respect, *viz.*, that the pelts go through three different stages known as suspenders, handlers, and dusters.

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[1] For details see R. A. Earp, in "Tanners' Year Book," 1910, p. 133 *seq.*

225. In the *suspenders* the pelts are suspended by the butt-end from poles, the ends of which rest on the sides of the pit. This system ensures all parts of the pelt coming into contact with the tanning liquor, whereas if they were piled one upon another in the pit then the liquors not having uniform contact with all parts of the pelts the latter would not be uniformly affected. Another advantage is that the surface of the pelt is kept smooth by its own weight, while if it were allowed to lie in the pit in a crumpled state then these marks would be fixed by the tannic acid and be very difficult to remove afterwards.

When the pelts have been in the first suspender for about three days they will be transferred to the second, containing stronger liquor, and after about three days more they will be moved to the third, where they will stay for a few days.

226. *Handlers.* The pelts are now laid down in pits which contain tanning liquor; these pits are called "handlers," and are so named because the pelts are "handled" so frequently, being often taken out of the pits and put back again and transferred from pit to pit by workmen with the aid of long poles, to the ends of which large hooks are attached; the pelts will probably go through three handlers, although a larger number may be used.

227. *Dusters* or *lay-aways.* In the final stage a different method is adopted. The bottom of an empty pit is strewn with some of the tanning agent, upon which one of the pelts is laid, it is then dusted over with a layer of the tanning material and another pelt laid on; this process is repeated until the pit is full, after which strong tanning liquor is added until the pelts are submerged.

The number of pits used, and the length of time the pelts remain in each pit will vary considerably; the strength of the tanning agent used, the substance of the pelt and the character of the leather it is desired to produce, will each have to be considered. This method is used because the pelts gradually extract from the tanning agent the tannic acid and other matter which will be finally deposited between the fibres; the result being what is described as a "well fed" or "well filled" leather The time allowed for the pelts to be in the *dusters* or *lay-aways* will vary between six weeks and six months.

The tendency of tannic acid is to contract the fibres, and if the liquors used are too strong they destroy their nature and burn them, the result being a brittle leather which would soon grind away. To counteract this tendency some acid which would cause the pelt to swell (§ 207) is sometimes added to the liquors in the suspenders; this would be the usual method if depilation had been by sweating, but old tanning liquors generally develop sufficient gallic acid for hides that have been limed.

228. When the leather has been sufficiently tanned (§ 223) it is taken from the pits and washed in weak tanning liquor, then laid in piles to drain, after which it is hung up to dry. Considerable care is necessary in the drying; a current of air is desirable, but keen winds may turn the leather a bad colour; it must not be dried too quickly, for

should the outsides be too dry the moisture in the inside could not escape; to correct this the leather may be stacked in piles for a few hours, as this retards further drying and affords an opportunity for the dried surfaces to draw the moisture from the other parts. The tanner is anxious to have the grain of the leather as clean as possible, but if the moisture is allowed to dry out from the grain side it would be discoloured by the residue left after evaporation; it is customary therefore to put a coating of linseed oil on the grain, and the moisture then finding it difficult to escape from this side is evaporated from the back. The difficulty of drying the leather increases with the increase of its substance, therefore heavy leathers generally require oiling twice during the process of drying.

229. Most of the tanning agents, except hemlock, mimosa and quebracho, deposit a quantity of white substance called ellagic acid or "bloom" on the grain of the leather; this may be left on, but generally it is removed by a process called "blooming" or scouring. The leather after draining, and while still very wet, is thrown over a "horse," or beam having a slightly convex surface, and the grain of the leather is cleansed with a stone, brush and sleeker; or, instead of hand-work, it may be done by machine (§ 235).

230. Another operation called "striking" may be performed when the leather is partially dried. The object is to remove the creases by pushing out the leather in the direction in which it will stretch. When this is done by hand the leather is worked over a beam with a striking pin, an illustration of which is given in fig. 86; there is a machine used for the purpose, in which a roller revolves and smooths out the grain of the leather.

231. When it is sufficiently dry the leather is carefully rolled upon a level, solid, wooden bed covered with zinc or brass to avoid staining the leather; the type of roller and the method of using it are shown in fig. 87.

When the leather is nearly dry it is again rolled, using greater pressure and a different type of machine (§ 259).

The grain may now be brushed to give it a clean finish, after which it will be ready for the market.

232. The final stages of the tanning operations are not often as simple as those which have been described. The leather when taken from the last of the tanning pits may not be a suitable colour for the market, and to correct this the tanner may select one of the following methods.

The leather may be put into a strong tanning liquor which would modify its original colour; *e.g.* shoulders or bends which have been tanned with materials that produce a light colour may be finished off with hemlock, mangrove or chestnut extract. Such treatment can generally be detected by examining the section, which will show the two colours, because only the outside of the leather will be affected by the colouring agent used (see § 246).

233. Sometimes the leather is bleached by being dipped into a strong

solution of either sulphuric or hydrochloric acid. When finished in this way it is important that all traces of the acid be carefully washed from the surface of the leather as its tendency is to contract the fibres of the leather and to destroy its nature. The acid which is not washed away has a tendency to collect together in drops or patches, and in such places the grain will be contracted, thus causing a mark which it will be impossible to hide with any style of finish.

234. Hemlock sides are generally bleached either with sulphuric or hydrochloric acid. Sulphuric acid may also be used in the suspenders, and sometimes in the handlers, because it hastens the penetration of the tannic acid and at the same time swells the leather (§ 207); this treatment adversely affects the quality of the leather, making the grain poor and the leather brittle; it is described as "Acid-tanned leather," whereas that which has not been treated in this manner is specified by the tanner or leather merchant as "Non-acid," meaning that the only acids used were those which naturally developed in the tanning liquors, namely lactic, acetic, and gallic.

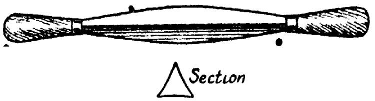

FIG. 86.

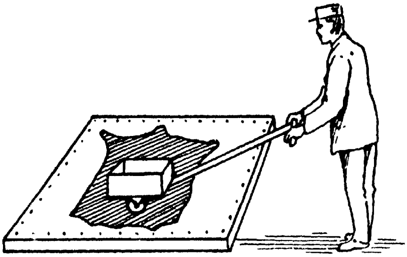

FIG. 87.

235. Another method of altering the natural colour of the leather is to scour off the hyaline layer (§ 110) which is always much darker than the grain fibres beneath it, the colour of which is called the "ground colour". No serious harm results from doing this, except that in the process of boot manufacture the leather is more likely to stain. When offered for sale sole-leather is often described as being "scoured" or "unscoured," but a little experience in comparing the difference in appearance caused by scouring will make distinguishing them quite easy; this scouring removes the slight unevenness in the surface formed by the papillæ and consequently the face of the leather is much finer.

Scouring is generally done by machine, and an abrasive is employed; thus it is easily distinguishable from the scouring or "blooming" referred to in § 229.

236. When leather has been scoured it is more penetrable by liquids, and can also be stained, dyed or bleached with less difficulty, and advantage is often taken of this by the tanner. Strong liquor may be made with sumach, and, while it is still hot, be put into huge drums; the leather is then put in and the drums made to revolve. The liquors penetrate quicker and more evenly than they would if the leather were only immersed, and therefore after a few hours its colour will have changed considerably, being now much lighter; but unfortunately this is not the only thing that has happened, for the hot liquors dissolve out some portion of the gummy sediment from the body of the leather, which in consequence will be more porous and less water-resisting. In the "Tanners' Year Book" for 1906 an account is given of extensive experiments made by Dr. Parker to demonstrate this.

237. Another method that is often used and which does not injure the leather, although it may deceive the buyer, is to paint the surface with a mixture that will produce the desired colour. A pigment—possibly chrome yellow or ochre—is mixed with size, glue or gum, and this mixture is well worked into the grain, the leather being afterwards brushed, and finally rolled. Annatto or aniline dyes may also be used to obtain the desired colour.

238. Leather that is sold by weight is often adulterated to increase its weight. The practice of leaving on the back of the hide a quantity of adipose tissue which never becomes leather is probably not so common as it once was; it is, however, not at all uncommon to see leather that has been thickly coated on the back with waste material from the tan-yard; usually no attempt is made to hide what has been added and no special test is necessary to detect it.

239. Filling the body of the leather with extraneous matter which serves no useful purpose, except to increase the weight and so bring more money to the tanner, is a practice which is very common in America, and apparently they do not deny it.[1] Glucose—also known as "grape sugar"—is one of the things commonly used. In small quantities it occurs in most of the tanning agents, but where it is certain that glucose had not purposely been added to the leather by the tanner, the testing of many samples only showed the presence of just over 1 per cent, whereas, according to the figures given by Dr. Parker,[2] samples of leather have been tested which showed an adulteration of as much as 16 per cent after making an allowance for the natural presence of glucose. The average adulteration of thirty-two samples was 7·2 per cent. The objections against the use of glucose are that—

(*a*) It gives the leather a fictitious weight.

(*b*) It is an easily soluble compound that readily absorbs moisture, and therefore the leather is not so suitable for footwear, because it becomes saturated in less time and takes longer to dry than it otherwise would.

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[1] "Tanners' Year Book," 1908, p. 31.

[2] *Ibid.*

Probably the easiest method to detect its presence is by soaking the leather for twenty-four hours in just sufficient water to ensure it being covered all the time; if the water has then become like a syrup the conclusion would be that the leather had been adulterated with glucose, but the following is a more reliable test: shred the leather, then put it into sufficient water to cover it; after about an hour drain off the solution and add an amount of lead acetate equal to one-tenth of its volume, this will cause a precipitate, therefore again filter the solution; the excess of lead acetate must now be precipitated by adding sodium sulphate equal to one-eleventh of its volume, after which it must again be filtered; the solution should now be put into a flask containing about 10 ccs. of Fehling's solution and then boiled; if glucose is present this deep blue solution will throw down a copious precipitate, greenish at first, but changing rapidly to scarlet.

240. Magnesium sulphate or Epsom salts is used in large quantities for the weighting of sole leather. In America this may be "drummed in" at the same time as glucose. The disadvantages through its use are:—

(*a*) The purchaser buys as leather that which is not leather.

(*b*) This added material does not improve the quality of the leather.

(*c*) The added matter being readily soluble, in wear it quickly dissolves out, leaving the leather porous and much poorer in quality than it previously appeared to be.

(*d*) It is always liable to throw off an efflorescent spew (§ 243) which will work through gum finishes or russets, and the darker the colour of the finish the more conspicuous will be the spew. Dr. Parker reports having tested samples of leather that contained 3 per cent adulteration with Epsom salts, but it sometimes[1] amounts to 8 per cent. An easy test is to soak the leather for twenty-four hours in just sufficient water to cover it well, then pour off the clear liquid and add a few drops of barium chloride: if magnesium sulphate is present there will be a precipitate of barium sulphate (see § 243).

241. Formerly barium chloride was often used, it was easily detected, however, by shredding the leather and soaking it, the resulting solution must be filtered, after which add a few drops of dilute sulphuric acid. If barium chloride is present there will be a white precipitate of barium sulphate. The tanners, however, after putting in the barium chloride, now give the leather a bath in dilute sulphuric acid; this bleaches the leather (§ 233) and also changes the chloride in the body of the leather into the sulphate, which is practically insoluble.

In this form barium is difficult to detect, as no wash out test is applicable. One method is to shred the leather and then burn it to an ash; this should be well washed with hot hydrochloric acid; a platinum wire, also cleaned in the acid, should now be dipped in the ash, so that a little adheres, and then held in a Bunsen flame; if the flame is turned a yellowish-green, then the presence of barium may be assumed.

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[1] J. A. S. Morrison, "The Leather World," 11 March, 1915.

Samples of leather have been known to contain 8 per cent[1] adulteration with barium chloride. Boots and shoes made with leather that is adulterated with barium are prohibited from being imported into the Australian Commonwealth.

242. Another method by which the weight of the leather may be considerably increased is to force into it very strong tanning liquor which leaves a quantity of uncombined tanning material in the body of the leather, giving it not only greater weight but more solidity.

The liquor and the leather are usually put into a drum which is made to revolve, and the leather, being thrown against the shelves and sides of the drum, is soon saturated with the heavy liquor. The objection to such leather is that the free tanning material which is simply held between the fibres and which has not become a part of the leather is very liable to dissolve out during wear; this may take place to some extent, but it is also possible that when worn under damp conditions some of the free tanning material may actually become a part of the leather. The test employed in this case is known as the "wash out" test (see § 253).

243. The surface of the leather may be covered with what is often described as a "bloom"; it is generally caused by a "spew," that is something which has come to the surface from the body of the leather.

Magnesium sulphate when present (§ 240) will produce this effect; it does not appear, however, if the leather is kept quite dry, but should it be allowed to become damp then the salt works to the surface and with the return of dry conditions it assumes the form of white crystals. The defect is not so common as formerly, because the use of barium chloride acting with the magnesium sulphate produces barium sulphate which, being practically insoluble, does not spew out (§ 233).

Barium chloride being a crystallizable salt (as also is magnesium sulphate) manifests itself in a similar manner.

Crystallizable salts on the surface of the leather can easily be distinguished from fungi by gently putting a drop of water on the surface to be tested. Salts quickly dissolve, leaving the surface of the leather clear, the area of the wet surface rapidly increasing in size, whereas if fungi are present the water will only spread slowly and the surface will still be covered with the growth.

244. There is another form of spew which does not in reality come out of the leather, but is developed on its surface because of what is inside; *e.g.* leather that is tanned with divi-divi is hygroscopic and will attract the damp from the atmosphere more than any other leather; if in addition there is something in the leather for fungi to feed on, then when such leather is damp all the conditions are present which are necessary for the development of this growth. Glucose quickly develops

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[1] "Tanners' Year Book," 1908, p. 47.

fungi, as can be tested by a simple experiment, as follows: make a solution of it in water; put this in a bottle and allow it to stand, in a few days the fungi will appear. The presence of fungi, however, is no a proof that the leather is adulterated, because all vegetable-tanned leather is subject to this growth unless an antiseptic has been used in the process of finishing. There is more than one variety of fungus tha grows on leather; some are white, in other instances it may be green blue, or yellow. Leather should not be allowed to remain in pile while it is damp, nor in a damp place, as dryness is the best preventive of its development.

245. Leather which contains a large quantity of grease (§ 258), *e.g* belting leather, welting shoulders or curried upper leathers, may have a whitish bloom on its surface caused by the exudation of the free fatty acids. This efflorescence can easily be distinguished from the crystallizable salt by holding it near a stove; a salt would not be affected by the heat, but fat would quickly melt and disappear. It may also be tested with benzene or ether, a drop of which would quickly remove fat but would not affect a salt; or a drop of water may first be tried, this would dissolve a salt but not affect a fat. I have a sample of vegetable-tanned sheep-skin which when tested with ether yielded 23·8 per cent. extractive matter.

246. Leather that is tanned with a quick tanning agent may not be of such a character that it is suitable for the requirements of the boot manufacturer, but it may not be convenient for the tanner to produce at a reasonable price the character of leather required, because of the difficulty experienced in obtaining a sufficient quantity of a suitable tanning agent at a remunerative price. Under these circumstances the leather is often only tanned, possibly struck out, and then dried, in which state it is put on the market for shipping. The tanners in the country to which it is consigned take off the belly and shoulder and then re-tan the bend with a suitable tanning agent.

For example, in Australia many cattle are killed, and mimosa abounds, the cost of preserving the hides can therefore be saved by partial tanning, after which the leather could be stored to wait for a favourable market. When such leather reaches England it is generally rounded as already described, and the bends retanned with hemlock or mangrove, which treatment considerably improves its quality, rendering it less porous and more water-resisting.

The cost of taking hemlock bark to Australia would have been considerable, otherwise it could have been used at the same time as the mimosa, but now that the use of extracts has become more general, and with the great reduction in the cost of transport which is thereby effected, it is not unusual to use extracts in conjunction with mimosa the result being that the quantity of pure mimosa-tanned leather on the market is not as large as it once was, and naturally there is less re-tanned mimosa being used.

CHAPTER XX.

WHAT CONSTITUTES QUALITY IN SOLE-LEATHER.

247. FLEXIBILITY is perhaps the most important characteristic which sole-leather should possess, for in the action of walking, if no footwear is used, with a 15-inch step the foot would be flexed 2000 times for each mile walked, and if suitable footwear is worn the sole would be flexed and straightened that same number of times. Leather that is not flexible will not stand this strain, but will break through fatigue just where the bending takes place; this is not at all uncommon when leather is used which has been tanned with a large proportion of valonia, and a similar result was not unusual with leather tanned with pure hemlock. Such leather is only suitable for a heavy class of footwear that is not designed to be flexible, for example, shooting boots, army boots, or workmen's heavy boots. As the class of footwear approaches nearer and nearer to the dancing shoe, flexibility becomes more important. The tanning agent which produces the most flexible sole-leather is English oak bark and this explains why it is so much used for belting leather.

248. The amount of nature left in the fibre is also important. This can be tested by cutting a thin section and rolling it between the finger and thumb; if the nature is gone from the fibre it will crumble to dust, but if it still retains its nature then only the filling will be rubbed out. A better test is to ascertain how small an amount can be taken up with a sewing awl, and what strain the amount taken up will bear; by always using awls that are uniform in size, and taking up a uniform amount, skill in this test will soon be acquired.

If turn-shoes are to be made the amount of nature which the fibre possesses will be very important, for should the leather be defective in this characteristic, then, when sewing, a larger amount would have to be taken up, and should the leather be very brittle it might even then give way.

When attaching the soles of welted work many stitches are used to an inch, and if the fibre has been robbed of its nature the sole will break away along the line of the row of stitches; hence the smaller the amount of nature left in the fibre the fewer must be the number of perforations made for sewing.

Even for Blake-sewn work, nature in the fibre is important, because of the channel which is required for the stitch to lie in; otherw[illegible] thin edge or lip of the channel may break away when it is being either opened or closed.

When the fibre of the leather has lost its nature, the leather quickly grinds away in wear, so that its value is depreciated even for top-pieces on the heels of boots, whereas leather that has a lot of nature left in its fibre does not break away but has to be cut by the grinding and as a result it lasts longer.

This lack of nature may be caused by one or all of three things.

It may be that the tanning agent which was used too forcibly contracted the fibres of the leather through being too astringent: because of this valonia cannot be used alone; mangrove and hemlock also have the same tendency although in a less degree. If the tanning liquors made from less astringent tanning agents are used too strong a similar effect will be produced, while in a special degree acid-tanned leather (§ 234) also lacks nature in its fibre.

249. The fineness of fibre is another test of quality. If two pieces of leather are selected, one having very fine and the other very coarse fibre (but otherwise similar in quality) and both are tested by holding them against a revolving grindstone or emery-wheel, it will be observed that the piece with coarse fibre wears away much quicker than the other, and this is what might be expected, since when a single fibre is cut a larger proportion of the entire substance is destroyed in the case of the coarse fibre than would be in the piece having fine fibre; therefore in selecting leather for soles or top-pieces fineness of fibre is important as an index to its quality.

The power of leather to resist bending is affected by the length of its fibre. Place several pieces of leather together, so that the substance is made up of all the pieces, and try to bend them; since they can glide one over the other it may not be difficult, but sew them together with stitches one inch long and they will be more difficult to bend, because they cannot now so easily glide over each other. If extra stitches are used, so that the average length of stitch is only half an inch, it will be still less flexible. The experiment may be repeated, each time shortening the length of stitch, and it will be found that the leather gradually becomes less and less flexible; in other words its resisting power increases. If we let the length of stitch represent the length of fibre, we shall find that the same thing is true in leather; for if three pieces are taken, each being of the same tannage and of the same substance, yet one piece having short fibre, another very long fibre, and a third piece medium, the resisting power will then be in the inverse ratio of the length of fibre; therefore for stiffeners or toe-puffs, where resisting power is essential, shortness of fibre is important.

Hides are not uniform in the fineness of fibre, in some breeds of cattle the fibres are coarse, *e.g.* the buffalo, whereas others are characteristically fine; they also vary with the sex and age of the animal, gradually becoming coarser as the animal grows older. Even in the different parts of any single hide it is not uniform, and because of this the quality of the leather varies with the part from which it is cut.

In those parts which would stretch or contract with the movements of the animal, we find the fibre is long, the length varying according to the ease with which motion may be necessary, but in those parts which are least affected by the movements of the body we find the fibre shortest and finest, *e.g.*, there will not be much stretching or contracting required in that part of the hide which covers the buttocks, consequently the fibres are both short and fine, whereas under the throat they are very long, so that the animal may move its head without difficulty, the skin stretching or contracting with each motion.

The same consideration accounts for the length of fibre just behind the fore-leg and in front of the hind-leg. If we consider the hide as having five degrees of fineness of fibre, number one being the finest and number five the coarsest, then fig. 65 will indicate the variation in its different parts.

The ordinary method of estimating the length of fibre is to bend the leather; if the fibres are short then the surface will scarcely be disturbed, but if they are long the grain will "pipe," or gather up in little ridges, the pipes increasing in size as the fibre increases in length.

250. Boots often have to be worn under damp conditions; it is very important that the leather of which they are made should not be bibulous, because the wearer then would soon have wet feet. Moreover, when leather is wet it is much easier to cut than when dry, whether it be with a knife or with the gravel on the path, and therefore it will wear away more quickly when wet; consequently for some classes of footwear leather that quickly absorbs water must be classed as inferior to that which resists the water for a longer period.

There are two methods by which the leather may be tested. The object of the first of these is to test the affinity of the leather for water, and is carried out as follows:—

A strip of leather 1 inch wide is so suspended that exactly 1 inch of one end is immersed in water; after twelve hours it is taken out and the distance measured that the water has been sucked up above the 1 inch that was in the water; for example: If at the end of twelve hours the leather was wet as far as 1¾ inches from the end, then subtracting the 1 inch that was in the water we find that the rise is ¾ inch (see § 254). That the tests may be more accurately compared it is essential to maintain uniformity in (*a*) the width of the strips; (*b*) the depth immersed; (*c*) the length of time allowed to stay before being examined.

Its affinity for water depends to some extent upon the tanning agent; divi-divi produces leather that is both bibulous and hygroscopic, whereas hemlock contains a quantity of resin which in the lay-aways (§ 227) may be deposited in the body of the leather, the result being that it has little bibulous tendency.

The affinity of leather for water may also be affected by its purity, as some adulterants quickly absorb moisture, for example either glucose or magnesium sulphate. In the second test known as the "water-penetration test," the leather is clamped to the bottom of a tube, say between the two flanges, A and B, fig. 88; water is then put into the tube

C and watch kept for the first drop of water that appears on the back (see § 255).

The foregoing test may be varied by reversing the flanges as in fig. 89, and using a bent tube as E, it should be sufficiently long that the water in it will be not less than 12 inches above the level of F; having clamped the leather between the flanges watch the surface of the leather and register the time required for penetration. It is important that the samples be uniform in thickness and from a similar part of the hide.

251. Leather should be well filled, *i.e.* the spaces between the fibres should be filled with—

(*a*) The hide substance which in the raw hide fills the spaces between the fibres, and which in the process of tanning should be converted into tanno-gelatine.

(*b*) The gummy substance which the tanning agent generally deposits in the hide while it is in the lay-aways; this is deposited slowly and therefore leather that is hurriedly tanned is often imperfectly filled; such leather is said to be "starved"; it does not keep out the water, neither does it wear well.

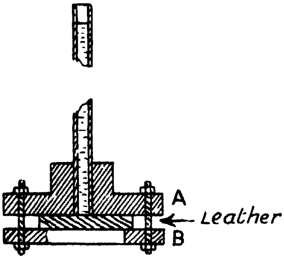

FIG. 88.

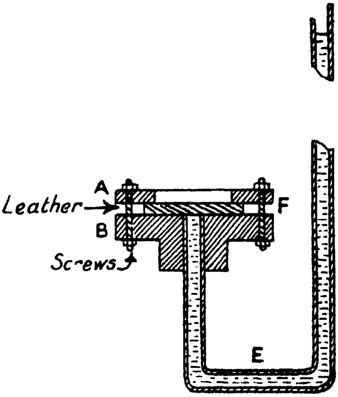

FIG. 89.

252. Reference has been made to testing the leather to find:—

(*a*) The time taken for water penetration.

(*b*) The tendency of the leather to absorb water.

Dr. Parker, in the "Tanners' Year Book" for 1908, has given tables showing the results of testing seventy-four samples of leather, including English, Canadian and American tannages; the leather was subjected to more tests than those to which reference has been made here, and by examining the results we may form some opinion as to their relation to each other and their utility to boot manufacturers.

The first column shows the percentage of moisture which the leather contained; all vegetable-tanned sole-leather contains moisture, which is unavoidable because all leather is more or less hygroscopic, it absorbs moisture from the atmosphere as one finds when leather is stored in a damp cellar. In the figures given by Dr. Parker for English leather the lowest was 13·4, and the highest 18·1; the average being 15·91 per cent. For the American leather the lowest was 14·4; the highest 19·8; the average 16·92 per cent. Assuming that the leathers had been stored under uniform conditions it is conclusive proof that average English leather does not attract moisture to itself to the same degree that average American leather does, therefore in this particular it is somewhat superior.

There is something, however, of greater importance to the boot manufacturer, *viz.*, the difference between the lowest and the highest results, which in the English leather was 4·7 per cent and in the American 5·4 per cent, since in purchasing the "same parcel" of English leather its weight may vary (according to the amount of moisture in it) between 97⅔ lb. and 102⅓ lb., but if it is a parcel of American leather it may vary between 97⅓ lb. and 102⅔ lb. The difference may be entirely the result of the conditions under which it has been stored, and it does not imply any intention on the part of the merchant to increase the weight. This certainly suggests the advisability of testing the leather at the time of delivery to guard against loss; this being especially important with bellies and shoulders.

The method of testing is simple: a piece of the leather is carefully shredded and weighed, then dried at 50° C. (preferably by steam-heat) for two hours, after which it must be weighed again and the amount subtracted from the first weight; multiply the difference between the first and second weight by 100, then divide by the first weight. The answer is the percentage of moisture.

Another method is after weighing, to put the shredded leather in a test-tube, which is heated in a water bath and the moisture collected in a calcium chloride tube, from the increase in the weight of the tube the percentage of moisture can be ascertained.

253. Leather may be tested to ascertain what amount of water-soluble matter it contains. The leather having been ground or shredded is dried at 50° C., after which it must be weighed; for two days it should be soaked in hot distilled water, after which the clear liquid may be filtered off and the residue dried at 50° C. If the difference between its present weight and its previous weight is multiplied by 100 and divided by its first weight, the answer will be the percentage of water-soluble matter. The loss may be as low as 14 per cent or as high as 30 per cent, the average being 19 per cent.

The information gained by the test should enable the boot manufacturer to judge as to the probability of the leather becoming impoverished through the water-soluble matter being dissolved out, and hence to estimate its suitability for a class of footwear which would be specially liable to be worn under damp conditions, as golf, shooting, or farmers' boots.

The water-soluble matter may consist of:—

(*a*) Uncombined tannin, *i.e.* matter forced into the spaces between the fibres, yet not becoming a part of the leather (§ 242).

(*b*) Glucose or some other water-soluble adulterant (§ 240).

The amount of loss is not a guide as to how the leather will stand the water penetration test, for samples which gave similar results by the washing-out test varied much in the penetration test :—

One sample showing a loss by washing 24·8; penetration test 13½ hours.
Another ,, ,, ,, 24·6; ,, ,, 233 ,,

The test is not a guide in determining its affinity for water :—

One sample, loss by washing 16·6; rise of water on strip of leather 2 ins.
Another sample, ,, 24·6; ,, ,, ,, ,, $\frac{5}{8}$,,

The test by itself does not indicate whether the leather has been adulterated :—

One sample, loss by washing 24·8; analysis showing total adulteration *nil.*
Another ,, ,, 20·8; ,, ,, ,, ,, 17·7.

254. The average amount of mineral ash yielded by English sole-leather is ·709, but samples of American leather have yielded 6·4. The test, however, does not appear to be *useful to the boot manufacturer* because it does not guide him in ascertaining either the water penetration, water absorption or adulteration as the following sets of observations from different leathers show :—

Mineral ash 6 per cent; water penetration 317 hours.
,, ,, ·6 ,, ,, ,, ,, 23 ,,
,, ,, ·6 ,, ,, rise on strip of leather 2 inches.
,, ,, ·6 ,, ,, ,, ,, ,, $\frac{5}{8}$,,
,, , ·8 ,, ,, total adulteration *nil.*
,, ,, ·8 ,, ,, ,, ,, 12 per cent.

It is useful, however, in determining the method of tanning, or the analysis of non-soluble weighting matter, and the investigation of materials used in dyeing or bleaching.

255. In § 250 reference is made to the water-penetration test. Attention should therefore be directed to the consideration of the limitations of its value, since it is not a guide as to the tendency of the leather to absorb water. This is evident from the tests made by Dr. Parker.

Water-penetration test 28 hours; rise on strip of leather 1 inch.
,, ,, 168 ,, ,, ,, ,, 1 ,,
,, ,, 116 ,, ,, ,, ,, 2½ inches.

Leather when tested the first time may stand the penetration test very well, yet on being tested a second or third time it may show very different and less satisfactory results. Experiments conducted by the author indicate that for the test to be really useful to the boot manufacturer in deciding the relative values of leathers to be worn under wet conditions, it should be first tested by soaking it for at least two days, then dried at about 50° C., after which the test for water penetration should be made. The importance of the soaking is obvious when it is remembered that :—

(*a*) Practically all leather is compressed more or less (§ 259).

(*b*) That this causes it to be more impenetrable by water.

(*c*) That when immersed for a time in water, the leather will to some extent spring back to its previous substance and in so doing become more porous.

(*d*) The water-soluble filling having been dissolved out, the leather will then be more penetrable.

256. Sole-leather is bought by weight, but two pieces of similar size and substance, even when cut from a similar part of the hide, may not be similar in weight; this may be accounted for in several ways.

(*a*) The amount of weighting matter added, either in the body or on the back, of the leather, often considerably affects the weight without appreciably affecting its substance (§§ 238-42).

(*b*) The amount of deposit precipitated in the body of the leather varies with the different tanning agents, together with the different methods of using them.

(*c*) The specific gravity of the different deposits or adulterants is variable.

(*d*) The amount of compression which the leather has received may vary.

Each or all of these factors may affect the density of leathers; the following test assists comparison: a small density bottle (one having a glass stopper and a vent for the escape of the excess) with a wide mouth, is filled with mercury and then weighed; a piece of leather, sufficiently small that it will pass into the bottle and not hinder the replacing of the stopper, is also weighed; this same piece of leather is now put into the bottle which is full of mercury and the stopper replaced, the excess of mercury will escape through the vent; the bottle is again weighed and its present weight subtracted from its previous weight plus the weight of the leather; the answer shows the weight of a volume of mercury having exactly the same dimensions as the piece of leather; therefore if the weight of the leather in air is multiplied by the specific gravity of mercury (13·56) and divided by the weight of mercury which was displaced by the leather, the answer will give the density of the leather when compared with water at 4° C.; for example:—

Weight of the leather in air	2·52	grammes.
" " " bottle and mercury	277·9[illegible]	"
" " " " " " and the leather .	280·43	"
" " " " " " with leather in it .	249·88	"
Weight of mercury displaced .	30·55	"

The weight of the leather in air (2·52), multiplied by the specific gravity of mercury (13·56), and divided by the weight of mercury displaced (30·55), gives the density of the leather (1·118).

It should be noted that mercury is used in the foregoing tests because water would be absorbed by the leather. The density could be found roughly by multiplying the length of the leather by its width and thickness, and then dividing the sum by its weight, the metric system being used for preference.

A special clamp is necessary when cutting, to ensure its edges being quite square, and a micrometer would be desirable for measuring, unless a large piece of leather was being used.

Formerly when each kind of leather was tanned with only one tanning agent, for example, either with mimosa alone, with oak-bark, or hemlock, the adulteration of leather being less general than now, the specific gravity of the different tannages was interesting. Of many tests made by the author the averages were as follows: pure oak-bark ·946; pure hemlock-bark 1·101; pure mimosa ·995.

These figures, however, did not represent the density of the leather at the time of using, because oak-bark tanned leather sinks considerably when hammered or rolled, whereas pure hemlock is so well filled that it does not require further compressing. The density of the oak-bark leather would therefore be considerably increased, and the original figures would not be a guide as to the density of the leather when used in the boots.

The study of the relative density of leathers yielded by different tanning agents may be interesting to tanners when experimenting with new tanning agents or new methods of tanning, but figures showing the yield of leather are more useful, for example: pelt weight of a butt 28 lb.; weight of the finished leather 20 lb.; yield of leather 71·4 per cent. At the present time, the producing of each parcel of leather with several tanning agents, or what is called "mixed tannage," is such a general practice that a knowledge of the average density of leather tanned with any particular tanning agent has little, if any, utility.

Neither are the figures of the density of any sample of leather which may be offered for sale any guide to the buyer as to purchasing, since it does not follow that because one parcel shows a density of ·950 and another 1·100 that therefore one is dearer than the other. Boots are sold at so much per pair and the value of the leather will depend upon how many pairs of soles of each quality one hundredweight of leather yields. This yield, in samples of similar density, will be governed by the rounding of the butt or bend, and by its quality in the poorer parts. As a general rule in leathers of light density the poorer parts are not as well filled as in leather that is more dense, hence fewer prime soles are obtained. Therefore the test is of little interest, and less utility, to the boot manufacturer, since it is neither a guide as to its value when purchasing, nor a test of its quality.

257. Belting and harness leathers are sometimes tested to ascertain their breaking strain; the value of such a test when the leather is to be used for reins or belts for heavy machines is self-evident, but a knowledge of the tensile strength of leather is not of value to the boot and shoe manufacturer, since it does not indicate either its water-resisting power or its ability to resist abrasion.

258. In looking over a tanner's price list we may find mention made of *Greasy Butts*, and the question arises as to the cause of the grease.

In § 202 reference is made to the fat-cells in the centre of the substance of the hide. The quantity of fat which is present will vary according to the breed and condition of the animal; those which live in the colder climates have a considerable amount of fat both in and under the skin, where it serves the useful purpose of helping to keep the animal warm, but it is in hides which come from cattle specially fatted for market that the greatest quantity of fat is found.

To clear the hide of this fat, the cells which contain it must first be broken down; this may be accomplished by the lime—if lime is used for depilation—the fat being converted into lime-soap in the body of the leather; if, however, in the after processes strong acids are used, either mineral or organic, the lime-soap will be decomposed and the grease be again set free;[1] this will discolour the leather and cause a lot of trouble when the boots are being finished.

When depilation has been by sweating, or if very weak limes have been used, then the unconverted fat may cause much trouble by working to the surface, even in the finished goods.

Greasy leather may also be the result of imperfect fleshing, since there is embedded in the loose fibre on the flesh side of the hide a large quantity of fat cells, and this fat should be forced out, as well as the pieces of adhering fat being cut away.

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[1] Prootor, "Principles of Leather Manufacture," p. 126.

CHAPTER XXI.

ROLLING OF LEATHER.

259. ONE of the most important of the operations which are performed in the sole-leather room is the rolling of the leather.

We have remarked (§ 258) that leather can be cut with greater ease when it is wet, and that therefore it would wear away much quicker than if it were dry. This being so we may conclude that anything which can be done to the leather to delay its becoming saturated must add to its wearing power, and hence to its value. Before the leather can become saturated the water must percolate between its fibres, but the spaces between the fibres contain a quantity of tanno-gelatine and other matter of a gummy nature deposited by the tanning agent while the leather was in the *lay-aways*, and in proportion to the completeness with which the spaces are filled so will the percolation of the water be rendered more difficult.

When the leather leaves the tanning pit, if it has been perfectly tanned the spaces between the fibres will be completely filled, but the filling will be in a saturated condition. In the process of drying a shrinkage will take place, the effect being that the spaces will then be less perfectly filled. The amount of difference between how the spaces are filled before and after drying will vary according to the tanning materials used and the rolling which it receives (§ 231); pure hemlock-bark probably yields leather that, if dried direct from the tanpit (without rolling), would be more perfectly filled than that yielded by any other tanning agent.

It being hardly possible to tan leather which after drying will be perfectly filled, recourse is had to another method of securing perfectly filled spaces, *viz.* the size of the spaces is reduced by a process of compression. This compression, however, can only be accomplished under certain conditions. When the leather is compressed the shape of the spaces between the fibres will be altered, but the tanno-gelatine while dry cannot adapt itself to the shape of the reduced space, it being hard and brittle; it also has an irregular form with many keen edges, therefore, being much harder than the fibres, any attempt to compress the leather results in the fibres being bruised and weakened and the brittle tanno-gelatine possibly reduced to powder.

The tanno-gelatine must be brought to a plastic condition before the leather can be compressed; it would then adapt itself to the altered shape of the spaces. The first thing necessary is to wet the leather, and this must be carefully done or it will be stained.

260. A tank or trough should be used, which is sufficiently large that the leather can be immersed, because it is difficult to prevent water stains when only a part of the leather can be wetted at a time. The tank, if it is made of wood, should be lined with zinc or lead, because some portion of the tanning agent always dissolves out and part of this would be absorbed by the wood. When clean water is put in the tank it draws some of this tanning agent from the wood and consequently it is hardly possible to keep clean water in the tank; cisterns constructed with glazed bricks are not at all uncommon, and it is then an advantage to use bricks that are light in colour, since it will be easy to see when the water is dirty; arrangement should always be made for emptying the tank without difficulty. When the leather in question is to be used for soles which will receive a light finish, either with gum or stains, it is very important that the water be clean, soft, and pure. Sometimes well-water is used, but as it often contains a quantity of lime, it will not penetrate the leather as quickly as soft water. Hard water can be distinguished from soft by dissolving sufficient castile soap in distilled water to make a solution of a milky colour; add this to some of the water to be tested and shake thoroughly; if a fine "head" or lather comes to the surface then the water is "soft"; if there is no lather, but a *curd*, then the water is "hard". To soften hard water use half a pound of borax to each 100 gallons of water. It is important that the water be pure; it often contains iron and this quickly discolours sole-leather. The slightest presence of iron in the water can easily be detected by adding a few drops of potassium sulpho-cyanide to a little of the water; if iron is present the solution will turn blood-red. Another test is to boil some of the water in a test-tube; if sufficient iron is present to damage leather, a brown precipitate will fall, which may be filtered off, and treated with a tan liquor, which will turn it black.[1] The leather should remain immersed until the water has penetrated to its centre. This is important because only that portion can be effectively compressed which is correctly prepared. The length of time necessary for any leather to remain immersed will depend upon its water-resisting power, its substance, and the part of the hide; *e.g.* shoulders or bellies would not resist penetration as long as a bend or butt, neither will the time taken be as long as that shown by the penetration tests in § 250, because then only one side of the leather came in contact with the water, that being the grain side, whereas now the water comes into contact with both sides, the flesh side also being more porous than the grain side.

Although the leather may be wet through the whole of its substance, it is not yet in a suitable condition to be compressed; there would be a quantity of water upon its surface, more or less charged with free tannic acid drawn from the leather, and if iron or steel came into contact with this the result would be a compound of iron which causes an indelible stain on sole-leather. This can easily be tested by soaking a piece of leather and then allowing some iron nails to rest on it for a few minutes; the nails will often cause a stain which penetrates to some depth.

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[1] R. A. Earp, in "Tanners' Year Book," 1909, p. 68.

If an attempt be made to cut the leather which is just taken from the water, and then the leather is laid aside for some time—say twelve hours—a second attempt being then made, it would be observed that the leather after standing could be cut with much greater ease, the reason being that although *the water had percolated between the fibres, yet the fibres and solid matter in the spaces were (previous to standing) still hard.* If some water is poured on a basin of dried peas it quickly percolates between them, but the peas are not therefore soft, the water must now percolate into the dense body of the pea and this will take some time. In a similar manner the water quickly percolates between the fibres and around the masses of tanno-gelatine which fill the spaces, but it must continue its penetration into the fibres themselves and into the filling, until both are sufficiently plastic that they can be compressed; this will require some time and is known as "*mellowing*" the leather. The general practice is to wet the leather in the afternoon and stack it in piles, and cover it with damp sacking to prevent the moisture evaporating from any exposed parts; it is then allowed to remain until the next day. It should not be permitted to remain damp long enough to become mouldy or the result may be discoloration.

261. The methods of compressing the leather may be grouped in two classes: First, those where it is accomplished with a series of blows; secondly, those where the leather is passed through parallel cylinders.

The earlier method is that of the first group. The shoemaker having mellowed the leather takes either a lapstone or flat piece of iron and administers a series of blows; commencing at one corner or sometimes in the centre, he causes each successive blow to lap over the previous one. The face of the hammer being slightly convex, at each blow the leather will try to avoid the compression by stretching in every direction.

When leather is compressed in this way no difficulty arises through its being uneven in substance, since the face of the hammer is so small; it can also be caused to fall with equal or unequal force, just as desired, and should one part of the leather be inferior in quality so that it became thinner with the compression, even this would not prevent the uniform compression of every part. The method is, however, open to serious objections:—

(*a*) It is only possible to use it when the leather is in comparatively small pieces, generally not larger than would be required for a pair of men's soles.

(*b*) The shape of the pieces is so much altered that as a rule they would require re-shaping.

(*c*) The time required to do it would add considerably to the cost of production.

The compressing of leather with a machine built on the principle of a mangle, but having steel cylinders, was one of the earliest of the engineer's innovations in the shoe trade.

The pressure to which the leather is subjected can be regulated by the operator. By this method the leather will only be stretched in the direction in which it is fed into the machine, but the rollers automatically adapt themselves to varying thicknesses of leather; for example, if a range of leather is being rolled and one of its ends is much stouter than the other, the cylinders will adapt themselves to the change in thickness; but if one side of the range is stouter than the other side the rollers cannot adapt themselves to this, since they can only move in such a way that they always remain parallel to each other; therefore the stoutest part would be well compressed, but a lighter portion would only be partly compressed and the lightest part might not be compressed at all. If in the process of fleshing the knife cut into the substance of the pelt, when the leather is rolled these places, which are light in substance, do not get any compression, this being prevented by the substance of the surrounding parts.

The "C" roller is so named because its frame is designed in the form of a C with the rollers in the aperture. It was introduced to enable large pieces of leather (which are always uneven in substance) to be rolled by power-driven rollers, and that the operation might be more effective the machine is fitted with small cylinders, about 16 inches long. These rollers are very useful for butts, bends, shoulders, or bellies, but they are not used for ranges. They are especially useful for bellies since these cannot be made to lie flat enough to be rolled on the ordinary rollers.

It is admitted that leather cannot be compressed as effectively by rolling as by hand-hammering, but the cost of the latter precludes its use in wholesale manufacture; the "Girder" pattern of machine-hammer has therefore been introduced and the results obtained are in the highest degree satisfactory.

262. Leather must not be compressed while it is so sodden that the pressure squeezes out any moisture, since this would contain a considerable amount of tannic acid, which on coming into contact with the steel roller would cause a bad stain; moreover that which is squeezed out is a part of the filling in a saturated state, and its loss would impoverish the leather.

Leather must not be excessively rolled, since there is a limit to the possible compression of the tanno-gelatine and nothing could be gained [illegible] attempting to compress it still more; with the fibres it is very differ[illegible] there is a limit to the compression which these can endure and [illegible] compression results in bruising them on the harder tanno-gelatine, and the effects are that the leather is weakened and its flexibility destroyed. In wear such leather grinds away quickly (there being no nature left in the fibre), and its flexibility being destroyed it is liable to break where the sole is flexed in walking.

It is sometimes asked, why one should roll leather that has already been rolled by the tanner. This is easily understood by considering why the tanner rolls the leather. It is because it improves its appearance and makes it more saleable. If leather were only dried after coming from the tanpit, without being either pinned (with a striking pin) or rolled, then it would have a crumpled appearance and not be very solid. The striking makes it smooth on the face and the rolling makes it appear to be better filled, but the degree of solidity imparted to the leather by the tanner will depend upon the average demand of his clients, it being well understood that the boot manufacturer can further compress it if he so desires. Some parts of a butt are better filled than others, *e.g.* the rump as compared with the shoulder; therefore all parts do not require the same amount of compression, but it is much easier for the boot manufacturer to vary the amount when he has it cut into sections than it is for the tanner to do it while it is whole; furthermore some parts of the leather being prime may be wanted for sewround soles which must be flexible so that they can be turned, whereas the poorer parts of the same butt may only be good enough for a commoner class of McKay-sewn, for which the leather may with advantage be further compressed. Even for heavy work, however, it is not always necessary that the boot manufacturer should compress the leather. If the tanner has specially prepared it for shooting or army boots and used a large quantity of valonia in its production, it may already be so well filled and rigid that further compression would reduce rather than improve its quality.

By intelligently compressing the leather the boot manufacturer can often add to its suitability for some specific purpose, and by increasing its suitability he increases its value, because apart from the extra compression given, he may not have been able to use it; therefore the operation is not only one of utility but also of economy, the increased value being greater than the cost of the operation.

CHAPTER XXII.

USES AND REQUIREMENTS OF THE PARTS CUT BY THE BOTTOM-STOCK CUTTER.

263. Before proceeding to describe how the different leathers are cut up we must first consider what pieces may have to be cut and the characteristics each should possess.

For most of the methods of direct attachment (§ 351) an insole is put on the bottom of the last, and the edge of the upper folded over on to the insole; tingles are then generally used to hold the upper in position until the rest of the bottom is secured. So that tingles can be used, the insole must have sufficient substance that together with the upper it is nearly equal to the length of the tingle; it must also be sufficiently close in texture that the bur of the tingle is not pulled through by the strain of the upper, which will vary according to the substance and harshness of the material used in the upper and to some extent according to the tension used in lasting. There should be sufficient solidity in the insole for it to lie flat on the bottom of the last, even though the upper be harsh, but if it be either too thin or too soft it will not do this.

A second useful purpose served by the insole is to keep out the sides of the upper, even though the material may be stout or harsh, and show the outline of the bottom of the last on which it was made. If the upper is of soft material this will not be a severe strain on the insole, but it may become considerable when the uppers are stout and hard, such as waxed kip, or waxed split.

The third useful purpose served by the insole is to form a foundation to which the rest of the bottom can be attached, hence the character of the material required will necessarily vary with the character of the attachment.

For *Blake sewn*, where the bottom is held together by a direct thread attachment, the stitches being about $\frac{1}{3}$ inch long, substance in the insole is not an essential qualification, but the material used should be sufficiently firm that the tension on the stitch does not cause the insole to be unlevel.

Riveted work. With this attachment metal pins are used; on the outside there is a machine-made head, but on the inside a bur must be formed by the rivet striking on the last. The object of the bur is to prevent the rivet working back, therefore the face of the insole must be suitable for the purpose.

Screwed work. Here the solidity depends on the grip of the thread which forms the screw. Therefore, as far as it depends on the insole, the solidity will be in proportion to the ability of the material to hold the thread, and experience proves that the leather with fine fibres, especially when it is well filled, is the most suitable. Granting that suitable material has been selected, the holding power will then be in proportion to the substance of the insole, so that where greater strength is required the substance of the insole must be increased.

Pegged work. There is neither a head nor a bur to the wooden pegs used, the strength of the boot therefore depends on the roughness of the sides of the pegs gripping the fibre of the leather. If the insole is not very firm the holes gradually get larger and the boot becomes unsolid. Substance is also important, since it gives the peg more grip.

Goodyear welted. Here the edge of the upper and the welt are fastened to the insole with a horizontal thread seam. That this may be successfully done the leather must have considerable nature in its fibre, otherwise it will break away with the strain. The fibre must not be too long or the seam will pull out of shape. Substance will also be required so that the channels may be cut (§ 361).

264. *Substitutes for solid leather insoles.* For various reasons insoles are not always cut from solid leather. Sometimes for the purpose of increased flexibility either felt or stout specially made canvas is used; either makes an excellent insole for Blake-sewn goods, provided the uppers are not too stout for the material to hold the tingles at the toe and heel, but this difficulty could be overcome by reinforcing these parts with thin firm leather. Economy of material may make it advisable to devise a means of using up insoles which are too light. They may be reinforced with felt or coarse canvas, if the only requirement is sufficient substance to take up the length of the tingle, and neither the felt nor the canvas will decrease the flexibility of the insole or impair the utility for McKay work.

Insoles may be "self-backed," that is two insoles may be pasted together and used for one. This answers very well for McKay, and is also often used for riveted work, but for the latter it cannot be considered as being equal to solid leather.

For cheapness, light leather insoles are often reinforced with fibre board; sometimes fibre board with canvas backing is used, or even plain fibre board. These, however, soon fail from one, or both, of two causes: (*a*) The material may give way through fatigue at the place where the shoe is flexed when in wear; (*b*) perspiration from the foot may destroy its ability to hold the method of attachment.

When leather insoles are reinforced with a material inferior to leather, the inferior material should be put where it will have to bear as little strain as possible. In walking the friction of the foot would soon wear away felt, therefore the leather should be put next to the foot.

Fibre board cannot endure damp like leather; neither can it hold either the stitch or bur of the rivet as strongly as leather can, therefore they should not be put next to the foot.

To determine the relative order of merit of these substitutes for solid leather insoles, each of the following points must be considered:—

(*a*) Ability to hold the method of attachment.

(*b*) Ability to withstand fatigue.[1]

(*c*) Ability to withstand damp.

(*d*) Flexibility.

(*e*) Cost.

For screwed or for pegged work no substitute for solid leather has been found. For the substitutes for Goodyear welted see § 361 and for fitting the insole § 299.

265. The "stiffener," or "counter," is that piece of material which is put into the back of the shoe usually between the lining and the outsides. Several reasons are assigned for using it, the most usual probably being that it keeps the foot in its proper position in the shoe, and thus prevents the heels being worn down on one side, by causing the weight of the body to fall perpendicularly over the centre of the top-piece. The shoemaker, however, cannot be credited with believing this theory, since the probability of the weight of the body falling perpendicularly to the top-piece will decrease as the heel is increased in height, and there should not be any difficulty when only a very low heel is used, the rule therefore would naturally be to increase the strength of the stiffener in the same ratio as the height of the heel is increased. We do not, however, in practice use such a rule, for a lady's ward shoe with only a $\frac{3}{4}$-inch heel would probably have just as stout a stiffener as a lady's dancing shoe with possibly a 2-inch heel. Furthermore the probability of the foot not keeping in its place in the heel of the shoe would certainly be greater with very light uppers than with boots made from stout stiff leather, therefore a lady's satin shoe should require a much stouter stiffener than a man's cowhide boot, but the fact that we do not select the stiffener according to such a rule may be taken as conclusive proof that not this but other uses have determined its selection.

When studying the utility of the stiffener it is a good plan to make two shoes on the same last, one without a stiffener, and the other with a good stiffener; when the lasts are withdrawn and the shoes are compared one will appear to have the last still in it, but it might be difficult to determine on what last the other shoe was made since it bears so little resemblance to its companion. Holding the toe in the left hand and with the heel toward the right, one cannot, in the shoe without a stiffener, trace that well-defined curve in the back which is seen in the other shoe. Now turning the toe of the shoe away, and looking at the heel from the back, the double curve beneath the outside ankle will be sought in vain; that curve on which the last-maker spent so much time and which is so well defined in the model, cannot be traced in the shoe; there is no difference in the shape of its sides, the outside quarter being similar to the inside one.

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[1] *Fatigue* in this sense is a technical term in some other trades, and admirably expresses the tendency to break away with frequent bending at one place.

Turning to the other shoe it will be found that as is the model so is the shoe, each curve in the heel of the last is reproduced. To obtain this result is one of the objects of the stiffener, and a strong stiffener will be necessary if the upper is stout and harsh, whereas if the upper is soft and light a correspondingly light stiffener may be employed. Examining the two shoes again, it may be noticed that the one having a stiffener shows a line of tension from the heel to the toe which imparts to the shoe what a craftsman calls "life," whereas the shoe without a stiffener hangs limp, and bears very little resemblance to the model on which it was made.

In fig. 90 the dotted line AB represents the "life line" of the made shoe; now it is evident that this line could not be held taut without a post at the back of the heel; the stiffener answers this purpose, its shape in the made shoe being as the thick line CD, the sides—represented by the dotted line CE—serve as cross, or tie pieces, and prevent the top coming forward.

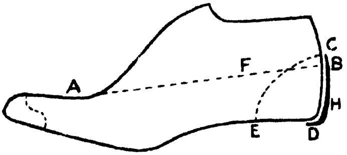

FIG. 90.

The post will need to be stronger for a large size boot than for a small size, seeing that the "life line" in one will be so much longer than in the other, and besides this the strength required will vary according to the stiffness of the material used in the upper. The stiffener which is only just strong enough to hold a light upper in position will not be strong enough to maintain the tension of a heavy and harsh upper.

The salesman endeavouring to find a shoe that will fit the foot of a lady who is desirous of wearing a very small shoe, will probably be anxious to impress upon us the importance of another useful purpose served by the stiffener, *viz.*, that it forms a post against which the heel of the foot can rest while the shoe is being put on. In fig. 91 the foot is being put into the shoe. The length line AB is not at the same angle to CD that it will be when the heel is quite down. If the stiffener is sufficiently strong that it does not yield, then as force is exerted at D the line CD will descend and the forepart of the foot be forced forward. If the boot is very small the strain on the stiffener will be considerable, and if the latter is weak then it will be forced backward and presently stand in a roll at G. Side-spring boots for elderly ladies are often restricted in the heel measure and it is also not unusual to find the stiffeners too weak, the result being that since the foot cannot go further forward the stiffener being weak is forced down at the heel.

That which assists the customer in putting the shoe on the foot, will also assist the workman in re-lasting the boot or shoe for channel-closing, bottom-levelling, or finishing, during the process of manufacture; and that which assists in forcing the foot forward when the shoe is put on for the first time, will also prevent it slipping back toward G (fig. 91) in the action of walking, as would be its natural tendency, since the foot is smaller at KL than at HJ. Greater strain therefore will be put on the stiffener in a tightly fitting boot than in one with more room; the strain will also be less in a very high heel than in a very low one, since the foot would not easily slip up an incline. To remove the boot or shoe from the foot is not always difficult, but it is far from easy with what is known as "long work," a boot-jack being then a necessity, a good stiffener, however, considerably lessens the difficulty.

266. In designing the stiffener its size and shape should be such that it will serve the purposes already named and yet not cause any discomfort. At the back of the finished shoe, its height (not including lasting allowance) should not exceed one-fifth of the length of the last or it will reach that part of the heel which alters its shape and size with the movements of the foot, in which case two evil effects might follow:—

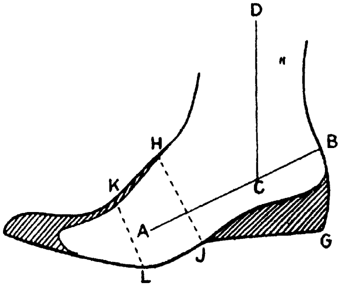

FIG. 91.

(*a*) The shoe would probably work up and down in walking, since when the foot is extended the top edge of the stiffener will be forced against the *Tendo Achillis*, and this not being soft enough for the stiffener to sink in, nor the stiffener sufficiently flexible to bend, the shoe is forced off the foot. If, however, the foot can bend the stiffener, then the top of it will sink down and form an uncomfortable ruck which may probably gall the wearer's heel.

(*b*) The hose is usually cut across at the top of a shoe through the excessive friction which is set up, but with boots the upper often breaks off where the top of a high stiffener comes, through the movement which takes place during walking being restricted, instead of being distributed over a large area.

If perfect results are desired the stiffener should reach to the centre of the inside waist; should it be shorter than this, the shape of the shoe may suffer, since the leather which is used in the uppers of boots is generally too elastic for it to retain a curve without assistance.

Another reason why a stiffener should not be restricted in its length is that when designing the insole great care is taken with its outline to ensure that its curves be faultless, but this is labour in vain, as far as the heel part is affected, if outside of this a stiffener is put which is so short that the scarf must be narrow at the ends; it should always be sufficiently long that a wide scarf could be used and the outline retained. Sometimes the shoemaker is unable to use an ideal shape stiffener because of the design of the upper, for example :—

(*a*) An unlined boot or shoe which has a small outside counter.

(*b*) A Derby boot which has a short cut quarter.

(*c*) Long-winged vamps machined on the lining.

(*d*) Slippers which have the counter and counter-lining all in one.

(*e*) "Long work," such as Wellingtons, where the seam is usually near the corner of the heel.

267. Ideal stiffeners should be made from solid leather, but two factors, economy of material and cost of production, are responsible either singly or in combination for substitutes being frequently employed. We cannot, however, judge the relative merit of these substitutes until we have considered what qualifications an ideal stiffener should possess; they may be summarized under three headings :—

(1) *The qualifications for utility.* (*a*) That it may be serviceable the stiffener should have sufficient rigidity to enable it to endure the strain that will be put upon it without losing its shape; this strain will vary with the character and substance of the material in the upper.

(*b*) It should be able to withstand the fatigue to which it will be subjected, otherwise it will break off by the seat of the sole; common cardboard cannot stand this test, if it is bent two or three times in the same place it breaks off. This strain would not be as great in a sheepskin upper as in one of tougher material, since the upper would so quickly give way, and the stiffener need only last as long as the upper.

(*c*) For some classes of footwear it should be able to endure damp, but obviously this does not apply to house shoes; good leather does not deteriorate through getting damp, but even the best fibre board soon becomes weak.

(2) *The qualifications for comfort.* A stiffener could be made from sheet iron, but the shoe would be so uncomfortable that it could not be worn.

(*d*) To ensure comfort the stiffener must have flexibility, so that it can yield slightly with the movements of the foot and spring back to its correct position; although essential in a glacé shoe, this loses its importance in those boots where flexibility is not expected.

(*e*) Lightness is often very desirable; stiffeners should never be used stronger than is necessary for efficiency, but some leather has so little rigidity that extra substance is unavoidable—such material should be avoided for shoes designed to be light in weight.

(*f*) Substance is important, since without it the stiffener could not be skived, and the edge would remain as hard as the strongest part; it would also be unsightly in appearance since its sharp outline would show through in the finished shoe, besides causing discomfort in wear. When there is sufficient substance these evils can be prevented by correct skiving (§ 315).

(3) *Qualifications to facilitate manufacture.* The stiffener should not be cut from material that is difficult to skive satisfactorily, *e.g.* a horny shank; neither should it be cut from material that cannot be compressed. The last around the edge of the seat (ED, fig. 90) is not as large as the heel of the last at its largest part (FB), and in order that the stiffener may be moulded to the shape of the heel of the last, it must be possible to compress the leather to that extent.

268. The following materials can be used for stiffenings :—

(1) Solid leather.
(2) Pigskin.
(3) Leather self-backed.
(4) Leather canvas-backed.
(5) Leather fibre-board backed.
(6) Fibre-board and canvas.
(7) Fibre-board.
(8) "Leather layers," or "pasted stock".

Leather layers are made from the pieces which come from the splitting machines pasted together until they make sheets with sufficient thickness, after which they are compressed and dried. To obtain sufficient resistance, the thickness used must exceed that which would be necessary if solid leather were used, and it should be remembered that when they come into contact with the damp they are quickly impaired.

To determine the relative merits of each of the materials, the following points must be considered :—

(*a*) Rigidity.
(*b*) Ability to withstand fatigue.
(*c*) Ability to endure the damp.
(*d*) Flexibility.
(*e*) Weight.
(*f*) Cost.

If a stiffener is not equally good at all parts the weakest part should be put either at the top or the end, not at the bottom, because a spring cannot be stronger than at its fixed end, neither can a stiffener be stronger than it is at the bottom where it is attached to the insole (see also § 300).

269. The material which is put into the toe of the boot to cause it to retain the shape of the last is known by various names as "toe-puff," "toe-casing," "toe-box," or "toe-stiffener".

When in the process of lasting an upper is strained over the toe of the last, it stretches considerably, and when the last is withdrawn it would contract so much that the toe of the boot would no longer resemble the toe of the last; therefore it is necessary to put into the toe of the boot something that will not contract, and which has also strength enough to resist the contracting tendency of the material in the upper.

A strong toe-puff is also necessary to enable the line of tension from the heel to the toe to be set up.

The ideal material to form the puff should have the following qualifications:—

(*a*) That it can, for the operation of lasting, be brought to such a condition that it may be easily compressed. In lasting there is always a considerable amount of fullness to be disposed of around the toe, and the difficulty of lasting it in will very largely depend upon the ease with which the leather can be condensed.

(*b*) The material when moulded should become rigid and hard.

(*c*) It should not be brittle, or it will not stand in wear.

(*d*) Its substance should not unduly increase the size of the toe.

(*e*) It should not be affected by the perspiration of the foot.

(*f*) It should "set" quickly, or the shoes would have to remain so long on the last.

(*g*) The material must not contract in drying, or it will not retain the shape of the last.

(*h*) Cheapness is often an important consideration.

The principal materials used to form the toe-puff are :—

(1) *Pig-skin* is sometimes very mellow and has all the essential qualifications. As a rule less substance is necessary with it than with any other leather.

(2) *Insole belly* also has all the essential qualifications and is easier to mould, but it does not "set" quite as quickly as pig-skin.

(3) *Split leather* has not as much rigidity as either pig-skin or insole belly, hence more substance is necessary and the size of the toe is thereby increased. Being porous it readily absorbs such compounds as box-toe gum and cement, which considerably improve its rigidity.

(4) *Celluloid* in thin sheets has been used. It must be softened with a spirit, but being so inflammable this is dangerous to use; celluloid adds to the size of the toe less than any other material, but is so brittle that it cannot stand any rough wear.

(5) *Buckram*, or canvas which has been specially prepared with heavy coatings of size, is very often used. It is not flexible, and therefore if through an accident it gets crushed, it does not recover itself as leather would. It is put on the market in various thicknesses, from which selection can therefore be made according to the resistance required.

(6) *Fibre-board* is stronger than canvas but not quite so easy to mould. The variety in the market is large and the merit varies considerably. Toe-puffs from this material are moulded by machine.

(7) *Box-toe gum* and *cements* are used in the form of thick paste. If used alone the paste will move from the place which receives the greatest pressure to where the pressure is less; the result is that the pressure being always greatest on the highest part of the toe, the cement squeezes away from it, leaving it weakest where it should be strongest, but this is obviated by using a thick, loosely woven canvas toe-puff.

(8) *Felt* is often used as a foundation for the cement; it is very absorbent, and as the pressure on the highest part of the toe is not sufficient to squeeze away all the cement, it makes a stronger toe, although it adds a little to its size, and even then it is doubtful if it is quite equal to canvas.

(9) *Combination toe-puffs* made from thin canvas and the waste pieces from the splitting machine are often used. It thus utilizes what would otherwise be of little value, but such puffs are no stronger than buckram.

(10) *Brown's patent india-rubber toe* is made of rubber specially moulded for the toe of a particular last. Affixed to it there is a margin of leather for lasting in. It has the advantages that it is not affected by damp and is practically indestructible, but it is too expensive for general use.

The student should compare the merits of the respective materials by considering how far each comes up to the ideal standard as tabulated (*a* to *h*) at the beginning of this paragraph.

The size and shape of the toe-puff required will depend upon the following circumstances:—

(*a*) The size and shape of the cap—whether peak or straight.

(*b*) If the vamp does not extend under the cap and an under-toe has not been used, then the puff should lap either over or under the skived edge of the vamp, otherwise the cap will fall in at the termination of the vamp.

(*c*) If a toe-cap has not been used, the toe-case should be as in fig. 90, since if it extended beyond the highest part of the toe the vamp may fall in at its termination, for the vamp will contract when the last is withdrawn, whereas the blocked portion could not.

(*d*) The shape of the toe of the last is important: if a toe-puff cut for a broad-toed last is used on one with a narrow toe, then at the corners of the toe there will be an excess of material, the result being that a thicker part of the skived edge will at these places be lasted away, the shape of the toe being thereby marred.

270. The piece of material which is placed on the bottom of the boot when it is lasted and which covers the forepart immediately beneath the sole is known as a "middle-sole," it being placed between the insole and the outsole; it is also sometimes called "slip-sole," "tap" or "half middle-sole".

Its principal uses are:—

(*a*) To increase the substance of the bottom and thus afford further protection for the foot either from damp or from rough roads.

(*b*) Sometimes it is used to deceive the buyer by making a light sole appear stout. In the process of finishing, to obtain a suitable angle for the impressing of the fudge-wheel the welt must be ploughed, but this reduces the apparent substance of the sole, and to avoid this reduction a middle-sole may be used that is just the substance required for "ploughing out".

The middle-sole may be cut either from bellies, shoulders, or the poorer parts of the butt. It is not subjected to the same strain as the sole, and therefore its quality need not be as high; sometimes split leather is used either from bellies, shoulders or bends, while in low grade work "leather layers" (§ 268) may be employed; but in canvas shoes and the slipper trade, even leather board or wood-pulp may be requisitioned.

The material selected for any boot should be such that it does not injuriously affect either the character or utility of the boot. Neither wood-pulp nor leather layers afford any protection from damp and hemlock sides militate against flexibility. The middle-sole should be capable of receiving a finish similar to the edge of the sole, and if a fudge-wheel is to be used suitable material should be selected (see § 92).

Sometimes middle-soles are cut so that they lock in (§ 93), this is often an advantage over a "runner" because the latter must be cut from material which is sufficiently mellow that it can be "turned," whereas with the skeleton middle this is not necessary. It is possible, therefore to use a less expensive leather. The skeleton middle is used principally in the heavy trade to assist the making of a flat bottom (see fig. 51).

271. It is usual to put into the waist of the boot a piece of material which is called a "shank," whose function is to assist in preserving the arch in the waist of the boot. The amount of strain to which it is subjected will depend upon the similarity between the shape of the waist of the last and the waist of the foot when supporting the weight of the body. If these are exactly alike, then so far as the shape of the boot is concerned a shank will not be necessary; in ladies' lasts it is not often that there is much similarity, except in those designed to carry very low heels, or in Court shoe lasts (§ 26).

Another useful purpose served by the shank is to prevent the waist of the sole being broken when the boot is being slipped off the last.

Special shanks are often used in boots designed to be worn either when digging or when climbing ladders, in order to make the waist rigid, and thus by distributing the force to lessen the strain on the waist of the foot.

The shank should be used as wide as the waist of the boot will permit without interfering with the method of attachment; for example, it should not be so wide that the McKay sewing passes through it.

The sides of the shanks should be bevelled down, since if this is not done the method of attachment may cause the sole to sink and it would then be difficult for the finisher to finish the waist properly. Another disastrous result is that the sole is very liable to be cut through by the McKay sewing, especially when the leather is brittle and the channel deep.

The shank should be used as long as possible; there will be no strength in it unless it is well caught under the heel; it should also reach far enough forward that it can support the whole of that part of the sole that does not rest on the ground.

The principal materials used are: leather, wood, fibre-board, steel, steel and wood, steel and fibre-board.

Unless they are made of leather, shanks are purchased by the shoe manufacturer, cut and moulded ready for use.

When combination shanks (steel and wood, or steel and fibre-board) are used, it is because the steel shank has not sufficient substance to give the waist the desired rounded shape.

To compare the relative merits the following should be considered:—

(*a*) *Weight.* Sometimes this is objectionable, as in ladies' very light goods, leather should then yield precedence to the steel shank.

(*b*) *Resisting power.* Wood is by far the most rigid and probably the best for heavy work; steel supported with wood comes next.

(*c*) *Spring.* By this is meant its power to return to its original shape. Steel yields to pressure and when the pressure is released the steel returns to its former shape, whereas leather gradually loses its power to do this, and fibre-board will not do it at all.

(*d*) *Shape of waist.* In boots with a broad waist it is an assistance to the finisher when they are well moulded and solid, or the same quality of burnish all over the waist cannot be obtained. For this purpose either leather, fibre-board or steel and fibre-board are satisfactory.

(*e*) *Damp.* Fibre-board is useless for wear under damp conditions, but either steel, wood, or wood and steel are suitable.

In selecting moulded shanks, the length, width, strength and similarity of the curve in the shank to that in the waist of the last are each important.

Leather shanks should always be mellowed before using, whether they are put in by the laster or moulded with the sole (see § 322).

DIREC Bengal

CHAPTER XXIII.

PRESSES AND PRESSING.

272. THE pieces of material used in bottoming boots and shoes are generally cut by knives that stand perpendicularly on their edge, and which are made to shape the material so that it can be used in manufacture without further modification. These knives do not "cut" the leather in the same way that cutting is generally understood, and which involves more or less of the saw action, but the knife is "pressed" through the leather, and the machine is therefore known as a "bottom-stock" press.

The knives may vary as regards their depth; those used on the "eccentric" presses are known as shallow knives, and are about 1¼ inches deep, whereas for the "revolution" press the knives are about 4 inches deep. The advantages of the deep knives are:—

(*a*) They economize time. The head of the press must be high enough above the block that it does not cause an avoidable obstruction to seeing the leather, but the higher the head the greater the distance it must descend to press or die-out the material; the distance, however, and with it the time, is minimized by using deep knives.

(*b*) They can be held in position while the leather is being pressed out, but if the leather does not lie flat on the block with a shallow knife this would be dangerous, as is proved by the number of accidents that have occurred.

The reason why deep knives are not employed on eccentric presses is that they would be so heavy to use, since when the knife is in position on the leather, it has, together with the block, to be pushed under the moving head of the machine.

Press knives vary as to the finishing of the inside; when this is ground smooth, piece after piece can be cut until the inside of the knife is full, when the pieces can be taken from the top of the knife. If the inside is not finished in this way each piece must be removed from the knife as it is pressed out, which causes considerable delay.

Deep press knives may be plain on the outside, they may have a flange as in fig. 92, or be ribbed as in fig. 93; the flange reduces the probability of fingers being squeezed off on the top of the knife, the rib also does this and reduces to a minimum the possibility of the knife slipping from the hand. Top-pieces for Cuban heels are often cut by knives that are designed to cut on the bevel at the back, this being a great advantage.

273. There are four types of "bottom-stock presses" in general use, and these may be again divided into two separate groups.

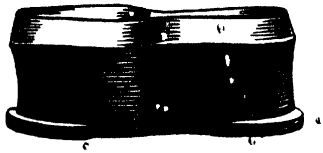

Fig. 92.

(*a*) Those in which the head of the machine is supported between four pillars—one being at each corner of a rectangle.

(*b*) Those which are formed something like a figure C, the pillar being at the back, and the sides left open.

(*c*) Machines may be built in either *a* or *b* style, but whose motion is continuous. Shallow press knives are used, being placed on the leather which rests on a block, and while the head of the machine is rising, the block and the knife are glided underneath ready for the downward motion to "cut" out the leather. These are known as *eccentric* presses.

(*d*) Machines may also be built in either *a* or *b* style, but so that they are motionless until the clutch is released, the head then descends, returns, and is again still. The press block remains stationary, since the knife can be put in position while the machine is not in motion. Deep knives are used, the machines being known as *Revolution* presses. If the machine has a radial arm like the "Ideal" clicking press, then very shallow knives could with advantage be employed. The arguments for and against the types *c* and *d* may be set forth as follows:—

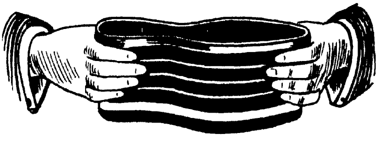

Fig. 93.

(*a*) For speed *d* is far ahead of *c*, for although *c* may be speeded up yet the greater speed may not secure an economy of time, since increase of speed means increase of difficulty for the operator in slipping the block under the descending head, and increase of difficulty also involves an increase of danger, whereas with type *d* the machine answers so quickly when the clutch is released that less time is taken waiting for the head to descend than is the case with type *c*.

(*b*) Power required. There is no doubt that a little extra power is required with large revolution presses of *a* pattern, but the advantages gained (§ 276) more than compensate for the extra expense, seeing that a smaller number of presses will be required. For cutting up pieces small revolution presses of pattern *b* are now made.

(*c*) Cost. The first cost of the machines in type *d* is greater than in type *c*; the deep knives are also more expensive, but when the time which they last is considered the extra cost has not much importance.

274. In England and America two systems are in general use for cutting up bends.[1]

In the method known as "ranging" or "stripping," the leather is cut into strips, each strip being the same width as the length of the sole to be cut from it.

The leather having been wetted and mellowed (§ 259) the ranging would proceed as follows:—

(*a*) Examine its quality and suitability for the purpose for which the soles are required.

(*b*) Scan the grain for any imperfections which may be there.

(*c*) See whether there are any flaws or imperfections on the back.

Should the leather be quite clear on the face and the back the general method would be first to make the leather at the tail-end square with the backbone, the piece which is cut off being known as the "aitch"[2] piece, fig. 94.

Enough should be removed with the aitch piece that the toe of neither of the first two soles is spoilt by the weakness near the tail.

Having marked the width of the first strip this can now be cut off and the process repeated until the whole of the bend is used. If a branded bend has to be ranged then the position of the defect should first be considered, otherwise two ranges might be spoilt by the cut passing through the brand, instead of the whole of the brand being in one range—as would usually be more economical.

This method of ranging by first removing the aitch piece is open to the objection that after cutting as many ranges as the size of the leather will permit there would frequently be some material left; hence there would be two awkwardly shaped pieces of material to work up from one bend; therefore when the quality and substance of the shoulder end is such that it can be used for soles it is then the better plan to commence ranging from the shoulder end, since that which is now left at the butt end equals what otherwise would have been in two pieces.

Stripping is often done with the well-known "guillotine" machine.

(*a*) It economizes time, being much quicker than a hand-knife.

(*b*) It cuts a straight edge, therefore the strip does not vary in its width.

(*c*) It cuts a square edge, which is almost impossible when cutting hard leather by hand.

(*d*) It economizes material, since the strip must be cut wider if its edge is bevelled.

275. Many manufacturers (especially in America) confine their trade to one quality shoe, although varying the design of the upper, and consequently only have a demand for one quality sole; under such

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[1] The term "B.A. bends" indicates that the hides were from Buenos Ayres; these hides are generally well grown, stout in the prime part and light in the offal, hence they command a good price.

[2] *Aitch* was originally *nache*, from the Latin *nates*, meaning the buttocks, but later instead of saying *a nache* people said *an aitche*, the initial *n* being thus lost. *Aitch* must not be confounded with *edge*, which is an entirely different word.

circumstances leather must be used which even [illegible] poorer parts is good enough for this shoe; but it is not possible to purchase leather which is uniform in quality in all its parts, neither can 100 bends be purchased which are all exactly the same in substance; yet it is not easy to make a large number of shoes the bottoms of which will be uniform in substance if the soles vary much in thickness; therefore manufacturers often find it to be an advantage after the ranges are rolled to put them through a levelling machine, this being much quicker than sorting the soles after they are cut, levelling those which require it and splitting any that are too stout.

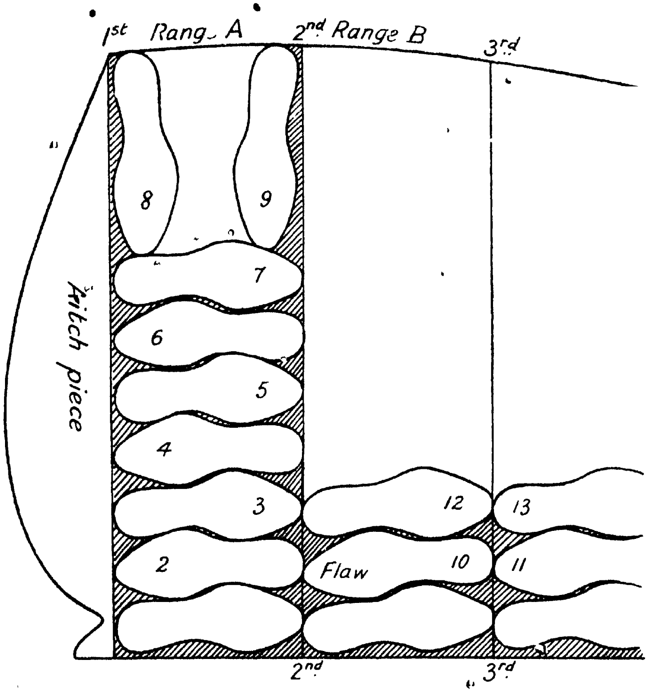

Fig. 94.

To level the ranges therefore economizes time, but apart from this if the *soles* are put through the levelling machine that which is taken off is not useful, it being too small, whereas if the *ranges* are put through, that which is taken off may sometimes be large enough to be useful and stout enough to be of service for re-enforcing either insoles, stiffeners, or toe-puffs; but should it not be desired to use the pieces in this way they can be sold for making "leather layers" (§ 268). When ranges are not levelled the soles which are above the standard might be disposed of to a "cut-sole" factor.

In cutting up a range it should first be examined for flaws or other defects; when this is not done it may sometimes be found that a weak place or bad warble hole may come in the forepart, which with forethought might have been put in the heel; for example, if in fig. 94 the toe of the first sole in the second range had been placed so that it pointed to the left hand, the flaw marked for the toe of the next sole would then have been in the heel, in which case the defect would not have affected its value.

When commencing a range, it is usual to place the inside joint next to the backbone, since the leather here is weaker and usually people do not as quickly wear away the sole at the inside as at the outer joint.

After cutting the first sole the leather should be turned over before cutting the second, as then the curves will more closely fit into each other and consequently there will be less waste; for the third sole the leather is again turned over, this method being continued until the whole of the range is cut up, unless the edge of the leather is too poor.

When the bend has not been rounded sufficiently close to permit the system being continued to the end of the range, then the heels of the soles may be turned to the edge as in the first range, fig. 94, soles 8 and 9; the forepart of both of these soles is in good quality leather and that the material in the heel part is inferior is not detrimental to the sole. Another sole of smaller size may be cut from the leather between the soles 8 and 9, and what is then left can be used either for top-pieces or lifts, according to its quality.

276. When the bend is cut up into soles without being first cut into strips, it is described as being "*cut direct*". Before being cut it should be mellowed, and may be rolled on the "C" roller (§ 261). On account of the size of the leather a revolution press will be required, and because of the difficulty of turning over the leather it will be advisable to have two knives instead of one, *i.e.*, a knife for each foot.

When cutting direct it is not usual to employ the arrangement shown in fig. 94, since with the majority of sole shapes greater economy can be effected; and if the sole shape will work in just as economically when the soles are cut all for one foot, then this would be an additional advantage since it would save time, for the operator gripping the knife with both hands, as in fig. 93, could, without putting the knife out of his hands or even changing its position, cut the first row of soles; then after turning the knife, he can, without having to turn the leather over, cut the next row; but when the leather has been ranged it must be turned over after cutting each sole, since the patterns then fit in better.

There are several systems of arranging sole patterns when the material is pressed without ranging. In the method shown in fig. 95, the soles underneath, which are shaded, indicate the save in length over the system shown in fig. 94; on the three rows it is equal to one-eighth of the length of a sole; in this arrangement the soles are cut in pairs.

In fig. 96 the soles are commenced with the inside joint and the side of the heel touching the backbone as in fig. 94, but in the second row the outside joint of the sole is fitted into the outside waist of the soles in the previous row; at first sight it looks like a wasteful system, but on closer examination it will be seen that there is practically no waste, except the piece between each four soles, and this is less than the amount of waste made by the system in fig. 94, in addition to which it is large enough to be useful.

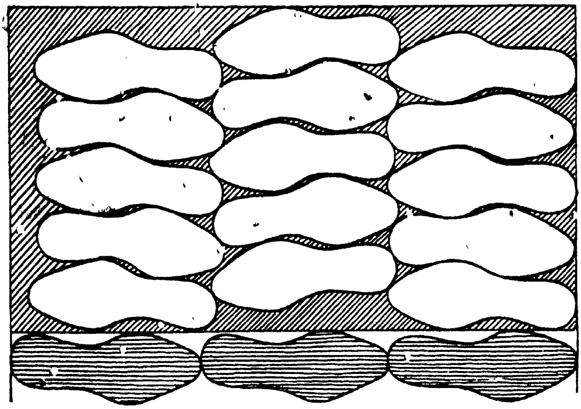

FIG. 95.

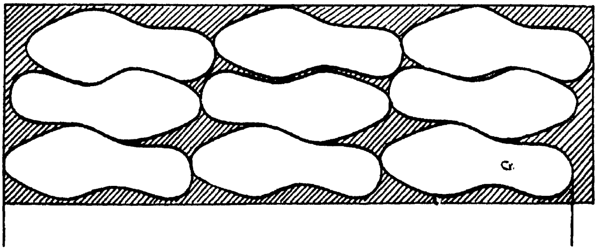

FIG. 96.

In fig. 97 the system is commenced with the outside joint and outside of the seat fitting against the backbone; the contrast between it and that shown in fig. 96 can be better seen by placing a straight edge from A to B in fig. 97. The size of the piece of waste between each four soles is considerably reduced, but it is also a less useful shape.

In fig. 98 the first row is placed as in fig. 94, but in the second row the outside of the forepart is placed against the outside of the forepart of the previous row, and in the third row the inside foreparts are similarly placed; with some shapes the system is useful.

In fig. 99 the first two rows are as in fig. 98, but the third row is

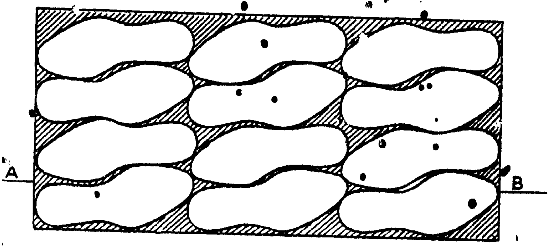

FIG. 97.

taken as in fig. 96, *i.e.* with the inside joint fitted into the inside waist. The pattern which has been used in the figure is not suitable for this system, since it is too hollow at the outside waist, but neither of the

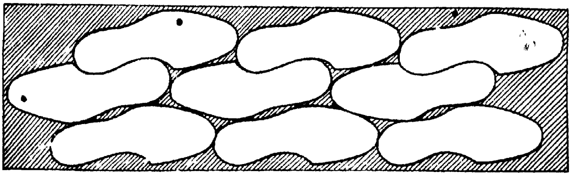

FIG. 98.

systems will be found to be always the best with every shape, otherwise only one system would be required. In fig. 100 the toes all point one way; the system is most useful for men's patterns.

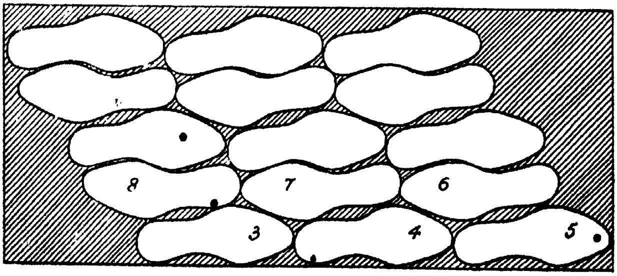

FIG. 99.

277. The advantages of cutting bends direct may be summed up as follows:—

(*a*) Low cost of production since more soles can be cut in a given time.

(*b*) Therefore a less number of presses will be required.

(*c*) Economy is effected since generally more soles can be cut from the material.

(*d*) Increased value of the offal, because when as many soles as is possible have been cut from the bend that which is left will be in one large piece, whereas if the leather had been ranged as in fig. 94 it might now be in five or six pieces; and since the value of the offal—that which is left after the soles are cut—depends largely upon its size, it follows that the value of the offal from leather that is ranged is less than its value would have been if it had been cut direct. Continuing the argument we see that even if soles were cut direct and placed as in fig. 94 there would still be a great advantage, since, apart from the value of the offal at the end of the ranges, the pieces that are left at the end of the soles in range A are only half of the size of the piece between the soles 10, 11, 12, 13, which piece by ranging would have been cut in two; this would be excellent material for piece lifts, and even if it is not required for use it has a market value.

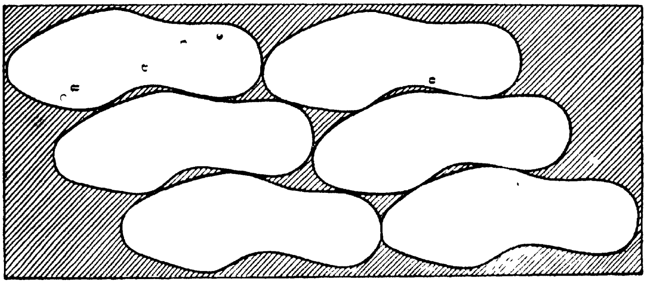

FIG. 100.

(*e*) Cost of ranging is saved.

278. It cannot, however, be claimed that the system has no disadvantages, since the following arguments can be brought forward in favour of the ranging system :—

(*a*) Save in expense because only one knife for each foot is necessary.

(*b*) The material can be selected to better advantage, for supposing that the butt end of the bend is much better in quality than the shoulder end, then the butt can be used for any size and shape for which it may be suitable, and the shoulder end used for something else; this cannot be done if the leather is cut direct, since then for each bend or side only one knife is used.

(*c*) When cutting damaged material ranging is by far the better system, since defects can then be avoided.

(*d*) Small orders can be more economically produced because the ranges can be stocked, instead of the cut stuff, and only the quantity and shape that is immediately required need be cut; this would be an important consideration where capital is limited.

When the direct system is used, if the whole of one bend is cut up for one foot, another bend similar in substance and quality should be selected for the other foot; to ensure this being possible, the bends should be paired before the cutting is commenced.

279. It is becoming a general practice to use what is called a "block knife" for both soles and insoles. These knives are so shaped that they fit in without waste, but as they do not fit any last it is necessary to shape the material afterwards by another machine. The arguments advanced in favour of block sole knives (sometimes called "master-knives") are :—

(*a*) With the constant change of fashion, new styles are frequently being introduced and others are then discarded. If a manufacturer cuts the material to stock with ordinary knives, he is liable to have on his hands a quantity of soles cut to a shape for which he no longer has a demand, and which cannot be recut to a present fashion. If the stock had been cut to block sole patterns this difficulty would have been avoided, since any shape can be rounded from one block pattern.

(*b*) It makes it possible to grade the soles in qualities more accurately. For example: if a manufacturer has a varied trade including a line on a broad toe last on which he uses a light substance sole, and a line on a narrow toe last which requires a much stouter and better sole, possibly also another line having a full round toe for which an average quality sole is used; then if the bottom stock cutter could cut up the bend with one block knife, the sorter would be able to select as many of the primest soles as he required and only reject for the lightest those which were too poor for the medium quality, but if this had to be left to the bottom stock cutter it would take much longer and even then sometimes would not be satisfactory. The system therefore makes more accurate grading possible.

(*c*) At the same time, therefore, it saves the time of the cutter, since he has not to be constantly examining the quality of the stock.

(*d*) A much smaller quantity of cut material will be sufficient, as it can be rounded to the desired shape as required, hence economizes capital.

(*e*) Large economy in the cost of press knives, the wood blocks used for "rounding up" being very much cheaper.

(*f*) It is a very common fault for the edges of soles cut by the press knife not to be square, but the rounding up machine leaves the edge perfectly square, which is a great advantage to the finisher.

Two arguments, however, may be advanced in favour of the ordinary press knives :—

(*a*) There is only one operation instead of two.

(*b*) Sometimes there would be a little save in material.

It is not unusual for manufacturers to have three or four sets of block-knives varying in width, and by this method the waste is reduced to a minimum.

The pattern used for fig. 101 is in constant use; the system can be commenced with either the inside or outside joint to the backbone; in the latter case the first and third rows pair up, but in the former system it would be the first and second rows.

280. Two types of machines are used for rounding up the soles or insoles cut by the block knives. In the *Planet* and *Julian* machines the sole is held by a clamp which presses it firmly against the wooden block. The knife (together with the circular table) travels round the block, cutting off the surplus. Insoles may be rounded a pair at a time, but soles are rounded singly.

Another type of machine is the *Champion* sole-rounding machine made by Messrs. Owen, Robinson & Co. of Kettering.

The template to which the soles are to be rounded is fixed in the machine at the left-hand side, and on the other side of the centre are the clamps (similar in shape to soles): from one to six pairs of soles may be put in the clamp at a time and when they are secured the clamp is pressed forward against the cutters which are held in a chuck and revolve similarly to the cutters in a heel-trimming machine. The template and soles also revolve until the whole of the outline has been brought into contact with the cutters. The template only needs to make one complete revolution, the soles being then perfectly shaped and the machine produces equally good results, even though the leather may be stout and hard.

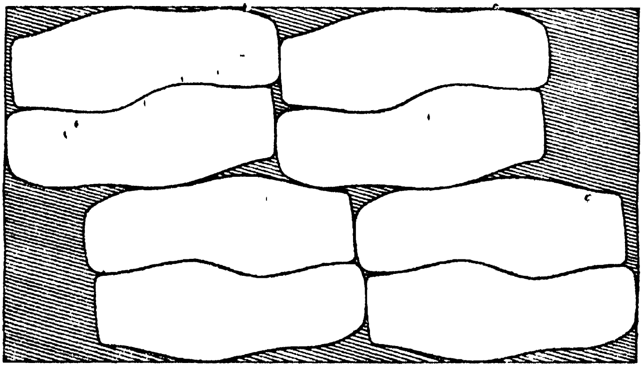

FIG. 101.

281. It is not unusual in making men's work to piece the seats of the soles. The operation is sometimes called "grafting," and the piece which is used to make the sole larger is called the "graft".

The graft may be made with a straight cut across (fig. 102) or it may be curved as in fig. 104; the two square edges may be fitted together or both the sole and the graft may be bevelled; there can be no doubt that better results are obtainable with the bevelled graft, since an increase of pressure would cause the sections to fit closer together. The argument advanced in favour of using pieced soles is that it enables a greater number of soles to be cut from the best part of the leather and also finds a use for the poorer parts which can then be used for the graft.

It cannot, however, be claimed that it is a very great advantage, for assuming that the graft is equal to one-eighth of the weight of the sole, yet the following expenses must be met:—

(*a*) The cost of the piece to form the graft.

(*b*) The cost of the extra operation to cut the graft.

(*c*) Cost of bevelling the sole and the graft.

(*d*) Extra cost of fixing a grafted over an ungrafted seat.

(*e*) Extra work for the finisher, especially when the graft is not well fitted and holes have to be filled with wax.

But even if only one-tenth of a penny per pair can be saved, yet on 5000 pairs it would be an economy of £2.

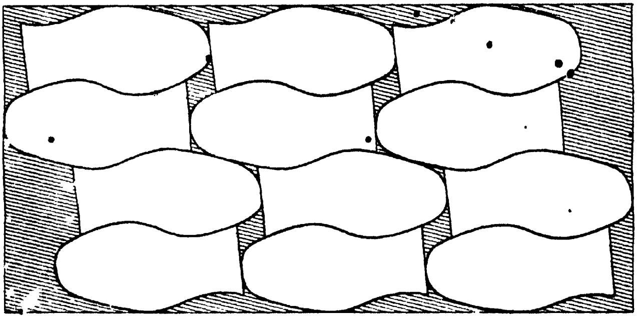

FIG. 102.

Three systems are shown for cutting grafted soles. In fig. 102 the soles are all cut for one foot, the only waste being one piece between each four soles.

In fig. 103 the rows are alternately left and right foot, while in fig. 104 the same principle is used as in fig. 102. There is a save in the amount of material used for the length of the three rows, and not any increase in width, but the waste is less serviceable and a little larger graft piece would be required.

282. The cutting up of butts does not differ much from the cutting up of bends; they must be mellowed in a similar way, and then ranged, after which they may be rolled.

The cutting up of butt ranges differs from the cutting up of ranges from either bends or sides because the backbone now crosses its centre.

There are three methods in general use:—

(*a*) If the ends of the range are suitable, the first sole may be cut at the end, placing the inside joint at the edge, this being the weakest part of the leather. The remainder of the range can then be cut as though *it were a bend range*, but this method cannot be used unless the butt has been very *closely rounded*.

(*b*) If the leather at the backbone is inferior, the range may be commenced by cutting a pair of soles so that the inside joint of each sole is placed at the backbone; both of these soles will be of inferior quality.

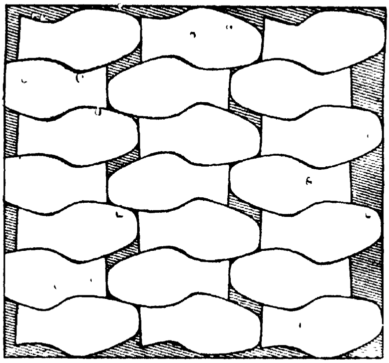

FIG. 103.

(*c*) Sometimes a sole is taken just on top of the backbone; this may be very much lower in quality than two soles (cut one on either side of the backbone) would have been, but there is only one poor sole instead of two.

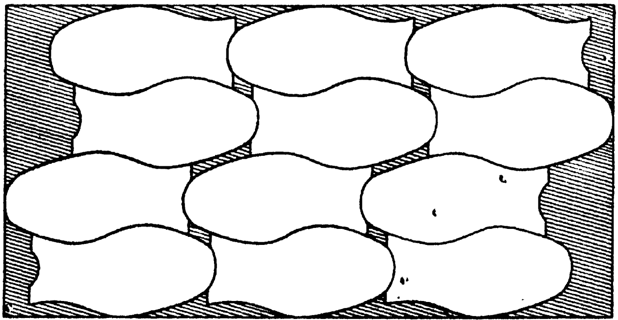

FIG. 104.

The cutting up of the remainder of the ranges would be similar to the cutting of bend ranges, and the soles cut on one side of the backbone should pair with those cut from the other side; they would not, however, be cut all for one foot from one side of the backbone and for the other foot from the other side, but alternately right and left as in bend ranges.

283. "Side" leather differs from the butt or bend in having the offal (the shoulder, belly and cheeks) left on. Sides are therefore considerably larger than bends and the method of preparing them for pressing will have to be determined by the presses available. If these are sufficiently large the leather after having been mellowed may be cut direct by one of the systems given in § 276, the soles being cut first, since they are the most valuable; every square inch of leather that is good enough should if possible be cut into soles. When this has been done the remainder of the leather, being smaller in size and less solid in character, may be rolled and then cut into that which is most needed, if it is suitable. When rolled the material could be given to another cutter because a smaller press could be used, and he would also have to use different knives; therefore if the first man had to cut up the whole side he might waste much time searching for suitable knives, but this is avoided if the first man only cuts soles, the second man only cutting through middles, half-middles, insoles or stiffenings, a third man being deputed to cut the whole lifts and a fourth the piece lifts.

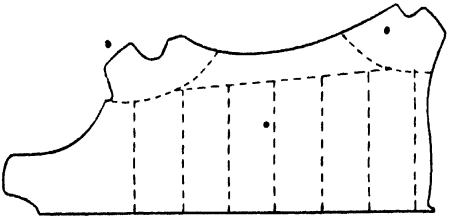
FIG. 105.

Subdivision of labour makes for efficiency, therefore the man who is constantly cutting offal should become expert in working up material that is irregular in shape; he should also be a better judge of what can be used for an insole or stiffener than one whose time is largely devoted to cutting soles.

When it is not convenient to cut the sides "direct," they may be prepared in either of the following ways:—

(1) The belly may be cut off, endeavouring only to remove that which would be too poor for soles, after which the shanks may or may not be cut from the bellies (fig. 105). The remainder of the side or as much of it as is suitable for soles in substance and quality may then be ranged as though it were a bend, and the shoulder be cut as described in § 292.

When only small presses are used and the ranging of the material is unavoidable this is perhaps the best way to prepare the leather, but however skilful and careful the man may be who trims off the bellies, he cannot always judge the substance and quality of the leather that is 9 to 12 inches from the edge, and even if he could do this, he could not trim the bend so that when the last sole of each range was cut nothing would be left over; it might sometimes happen that, with ⅛ inch more length another sole could be cut; the system therefore is not as economical as cutting direct.

(2) Sometimes the sides are ranged without rounding them (fig. 106);

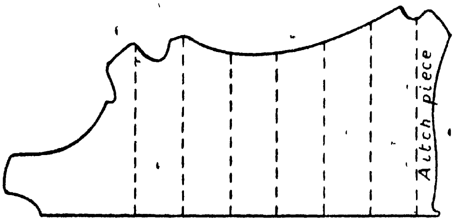

FIG. 106.

this prevents the loss to which reference has just been made, but there is the new disadvantage that the offal is cut into many small sections instead of being in one piece as it would be if the belly were first trimmed off.

(3) When sides are cut into soles for children's shoes they may be ranged as shown in fig. 107. The first cut should be taken far enough back to clear the weak place in front of the hind shank; this is important, for in the next range soles could then be taken farther out into the belly, because of the better quality of the leather, but this advantage would be lost if one side of the range included a part of the weak place marked A.

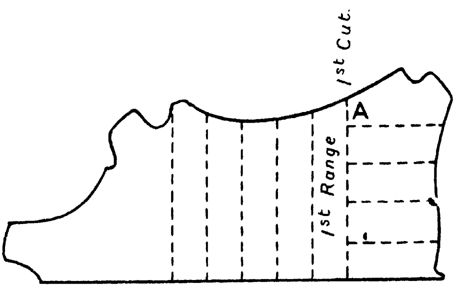

FIG. 107.

284. Australian sides cannot be treated in exactly the same way as hemlock sides, because hemlock produces a leather that is well filled and rolling is hardly necessary except for the poorer parts; pure mimosa-

tanned Australian sides, on the contrary, are usually soft and open, and rolling makes the leather more solid, although it considerably reduces its substance. The uses of the two leathers are also very different, the prime part of American sides is generally used for soles of the heavier classes of medium quality work, the poorer parts are used according to the necessities of the manufacturer and the possibilities of the material. Australian sides (unless of mixed tannage) are not often used for soles, except for light shoes, slippers, or canvas shoes; the prime part is often used for the insoles of men's welted work, the poorer parts for the insoles of Blake-sewn work, the light firm parts for Fair-stitched middles, the remainder in any part of the bottom for which the manufacturer may require it should its character permit.

Assuming that the side is to be used for men's insoles and that it is to be cut on a revolution press, the general plan would be to cut off the belly first (fig. 105), leaving on the bend only that amount which in its present condition would be suitable for such insoles. The shoulder may be cut off or left on according to the size of the side and the type of press available. For the cutting up of the bend on the direct system the reader is referred to § 276, or if the bend is to be ranged the same plan will be followed as is described in § 283. It is in the method of using up the belly that there is the principal difference between the manipulation of Australian and American sides; the former are soft and stretchy, being unstruck and unrolled; many manufacturers, therefore, mellow the bellies and then take the stretch out of them by a striking machine. Leather treated in this way is liable to shrink considerably as it dries, and therefore it should be thoroughly dried out before it is cut up, after which it may be used for insoles, middle-soles or lifting, but it is not quite suitable for stiffeners, since because of its softness so much substance would be required to secure sufficient rigidity.

285. Singapore sides are used principally in the manufacture of very strong work, such as nailed boots; they are specially suitable for this because of their resistance to water penetration, the prime parts not becoming sodden even though left in the water for a very long time; consequently when the sides have sufficient substance, excellent soles can be cut for low-priced nailed boots because the leather does not lose its ability to hold the nails on becoming sodden, whereas soles cut from leather tanned with pure oak bark would become soft in a short time under damp conditions and the nails would work out.

The character of the leather both as regards its resistance to water penetration and its rigidity, even when light in substance, makes it very serviceable for the stiffeners of heavy boots, which are designed to be worn under damp conditions, but it is not suitable for the stiffeners of ladies' light work, since it would be difficult to prevent its edge showing through the upper when the last is withdrawn (§ 267, *f*).

The leather may be used for through middle-soles, half middle-soles, or for insoles, but the sides vary so much in substance and may be used for so many purposes that the method of manipulation must be determined by the particular circumstances.

When side leather is cut direct, the following principles should be observed:—

(*a*) Follow the system and cut as many soles as the quality of the leather will permit.

(*b*) When the system cannot be followed any further, still cut as many soles as the quality of the material will allow, putting the best material in the fore-part and preferably at the outside joint.

(*c*) From that which is unsuitable for soles next cut that which will be *most profitable to you* at that particular time, and continue this method until the material is exhausted.

(*d*) When scrap is unavoidable, endeavour to let it be serviceable.

(*e*) When waste cannot be prevented, sacrifice the poorest of the material.

CHAPTER XXIV.

BELLIES AND SHOULDERS.

286. By referring to fig. 85 some idea may be formed of the general shape of the belly part of a side; it is not probable, however, that the reader will meet with many bellies in the market that are this shape, because in the process of striking they are stretched so much that they are considerably distorted.

The belly is not suitable for the same class of wear as the bend. The latter can stand friction since it has fine fibres, and should one of these be destroyed it is such a small portion of the thickness of the leather that the harm is not serious, but should one of the fibres of the belly be destroyed it is a much larger proportion of its entire substance, so that it is a most serious thing. The belly is therefore not suitable for any part of the boot which would be subject to much abrasion, *e.g.* soles or top-pieces.

The bend being so close in fibre and so well filled is not flexible, and for that reason it is not suitable for stiffenings, whereas the belly being longer in fibre and not so well filled is more flexible, and thus being softer in nature it can be so skived that its edge is scarcely perceptible in the finished shoe, therefore for stiffeners it is superior to the bend.

Flexibility is generally considered to be a desirable feature in footwear, but the flexibility of the shoe will somewhat depend upon the character of the materials used in the insole. Bends are not as flexible as bellies, therefore apart from the question of expense, if flexibility was desired, we should not use bends for insoles.

Weight in the made-up shoe is avoided as far as possible, and if suitable material can be obtained for insoles, stiffeners and heel stuff that is lighter in density (§ 256) than another kind, then that which is the lighter weighing would be chosen.

Since the belly is not suitable for soles, tanners in England always take it off and tan it separately with such tanning agents as will secure the greatest flexibility with firmness, solidity with light weight, and for some purposes, strength of fibre.

There are certain characteristics which are constant in all bellies, although they may be more noticeable in one belly than in another.

(*a*) The edge marked BH (fig. 58) is superior in quality to its opposite edge J because it is nearer to the best part of the hide, *i.e.* the bend.

(*b*) The substance of the hide gradually decreases from the buttocks to the shoulder, similarly that part of the belly which comes nearest to the buttocks is the stoutest, the fore-end being lighter. The difference in the substance of the ends is greatest in cow-hides and least in ox-hides.

(*c*) The hind shank is larger than the fore shank.

(*d*) The hind shank always has a tendency to be horny in character; even when it has been left in water for a long time it is often difficult to make it lie flat, and by testing it with a sewing awl it will be noticed that the fibre is very short and brittle.

(*e*) The parts which are just in front of the hind shank, and just behind the fore shank, are always light in substance, very long in fibre, and very loose in texture.

(*f*) The centre of the belly (between the two shanks) contains the best leather, it is more level in substance, less liable to stretch, has most strength in its fibre, and is most mellow.

287. Bellies are generally described according to the country in which they are tanned.

English bellies are usually from good class hides and often fairly wide; they are the most expensive, and when tanned with oak-bark alone they are without doubt the ideal leather for all purposes for which bellies are used; the majority of English bellies at the present time, however, are the result of a mixed tannage, this being a little less expensive.

French bellies are not often to be met with in the English market, although occasionally parcels of excellent leather—quite equal to English—may be purchased.

German bellies can often be purchased; quebracho is the principal tanning agent used, the leather often being from common and coarse-grown hides.

American bellies are usually tanned without being trimmed from the sides and these are fleshed by machinery; the leather is not as clean on the back as when it is fleshed by hand, but is usually stout, heavy and less suitable than English bellies for the lighter classes of boots; still it must not be overlooked that to-day America produces a greater variety of sole leather than formerly.

Australian bellies are usually tanned without being trimmed from the side; sometimes they are afterwards cut off and the bend retanned, when the bellies may be struck out and rolled. As a rule they are clean and light-weighing but inclined to be soft. Since the use of extracts has become more general, Australian bellies that are the result of a combination tannage may occasionally be seen in the market, and are much firmer than pure mimosa-tanned leather. Australian bellies (when the face is good) are often split, and the grain side finished for upper leather.

288. Bellies may be classed according to the method of finishing.

Unstruck or "*rough*" *bellies* are often used for hand-sewn work.

Struck or "*pinned*" *bellies* are what is used in wholesale boot manufacture, since if the belly is unstruck when it is purchased for hand-sewn work, the boot-maker must mellow, stretch and hammer the leather when he uses it, but this would take too long, and be too expensive for wholesale manufacture.

"*Split bellies.*" To obtain a sufficient supply of dressed leather manufacturers often have to split leather which would otherwise be too stout. The piece which is taken off the back may then be stuffed with glucose, heavily sized, and rolled (when sufficiently dry), after which it can be used according to its substance and quality for insoles, stiffeners, half middle-soles or toe-puffs. Bellies are also classed according to their size, weight or character.

Width. Bellies may vary in width from 4 to 12 inches; when they are about 9 inches they would be described as of medium width, but below 6 inches they would be described as narrow, while if 10 inches or over they would be wide. Narrow bellies are usually from well-grown ox-hides, very wide bellies from cow-hides.

Weight. For the convenience of manufacturers, leather merchants very carefully sort the bellies into different weights; they may be described as light, medium, or stout, but sometimes as many as seven selections are made. From 5 to 7 lb. per pair would be described as light; from 7 to 11 lb., medium; and from 12 to 16 lb., stout.

Character. Bellies are usually sorted by each tanner into "Best" and "Seconds," but as there is not any uniformity in the productions of the different tanners it is obvious that the words "best" or "seconds" cannot convey much information, unless the tanner's name or trademark is also given.

Bellies are often classed according to the purpose for which they are suitable.

Insole bellies must be from medium to light in substance, a good width, and fairly free from flay cuts if they are to be cut up economically; the degree of importance varies with the size of the insoles required.

Stiffener bellies must be correct in substance, be solid and flexible, as free from flay cuts as possible; width is also an advantage, but the last two points are not as essential as in insole bellies.

Middle-soles, or clump bellies. The important features would now be solidity and the substance desired, width is not so important and flexibility is not essential.

Lifting bellies. Leather that is damaged on the grain can be used for lifts; width in the belly is not important, since the parts to be cut from it are so small; if the leather is solid a good heel can be made with it even though the leather be acid tanned, and so brittle that it breaks when an attempt is made to bend it.

289. Three things determine the value *to you* of any parcel of leather:—

(*a*) The value to you of that which you will have to cut from it; if you want to cut lifting and you can buy suitable leather at 7½d. per lb. then best English bellies at 9d. would be dear to you, even though the price may be 2d. per lb. less than the regular quotation for that leather. The value to you of any leather cannot be greater than the value of that which you will have to cut from it; another manufacturer may be requiring this sort of leather and in that case it would be worth more to him than to you, therefore the value to you cannot be determined by its market value.

(*b*) The probable percentage of waste in cutting must be duly considered, since owing to the size and shape of that which you desire to cut, together with the size and shape of the material, the leather may be unsuitable; *e.g.* if the pattern is large and the belly is small the waste would be much greater than with a larger belly of similar quality, therefore to another manufacturer using smaller patterns the size of the belly would be far less important.

(*c*) If there is only a small proportion of the leather which is suitable for your purpose, even though the bellies are larger, yet they may not be worth so much to you as a smaller sized belly which contains a large proportion of suitable material.

290. Bellies are sometimes cut while they are dry; but they may be wetted and mellowed. To last in the toes of McKay work or to channel insoles for welted work would be difficult if the material were not dry, and this argument may be advanced when the leather is not cut to stock but to ticket; however, the advantages of mellowing may be considered as follows:—

(*a*) *Danger to the cutter.* Bellies cannot be made to lie flat like a bend, this constituting a serious difficulty especially at the hind shank; under such circumstances the knife must be gripped firmly and when shallow knives are being used the risk is considerable; the danger, however, can be greatly reduced by mellowing the leather.

(*b*) *Strain on the knife.* If the knife does not lie flat on the press block, the head of the press as it descends must first strike one side or one end of the knife instead of coming into direct contact with the whole of its top; this is a severe strain on the knife, the result being that in practice the knives which lose their shape in the shortest time are not those which are used for cutting the hardest leather (*i.e.* the sole knives), but the insole and stiffener knives, they being so often caught on the side instead of on the flat.

(*c*) *Accuracy of the shape of that which is cut.* When the knife is placed on material that does not lie flat, the shape of that which is cut will often be different from the shape of the knife, and it may be necessary to recut it, using a smaller knife; this involves a waste both of time and material.

(*d*) *Save in material.* If leather is cut while it is dry and while it is difficult to make it lie flat, then the operator cannot place the knife so close to the edge of the leather, because he cannot tell exactly how much the knife will alter its position when the leather is flattened out by pressure on the knife; he must therefore leave a sufficient margin to ensure the cut material being the full size of the knife, but this risk is averted when the leather is mellow, since it can then be made to lie flat, and usually it is not even necessary to hold it down, since being mellow it has lost the spring which it previously had, the result being that a much smaller margin is required between each cut; therefore it is more economical to mellow the bellies before pressing.

(*e*) *Economy of time.* If the conditions are improved under which work is done the natural inference is that it could then be accomplished in less time, for every pressman would urge that he ought to be allowed longer to cut a given quantity of material that will not lie flat as compared with other material that would, since under the last-named conditions no time would be lost trying to fit the knife on parts whose exact shape it may be difficult to determine; neither would it require as long to slip the press block under the head of the eccentric press, since the knife would be less likely to slip out of position; in addition to which the danger to the workman being less he has more confidence and the strain on his nerves being less he can work quicker—an economy of time being effected.

(*f*) *Parts cut are in a suitable condition to roll, level, or mould.* When material has been cut it is next taken to the sorter whose duty it is to level any pieces that may require it, split any that may be too stout, or roll any that are not sufficiently solid; if, however, the leather is cut while it is dry it would not be in a suitable condition to be improved by rolling, while to wet and mellow just a few parts would often be inconvenient; therefore the operation is omitted, whereas if the leather had been previously mellowed the parts would now be in an ideal condition to benefit by compression.

In § 319 the moulding of the parts is considered; experience proves that insoles moulded when they are dry do not retain the shape of the mould, but when bellies are mellowed prior to pressing the cut stuff would then be in an ideal condition for moulding.

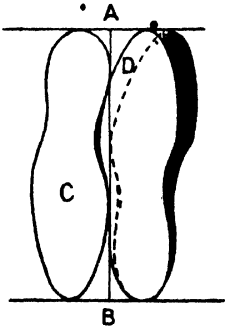

FIG. 108.

291. There are many methods of preparing bellies for pressing; when they are cut without mellowing they are sometimes commenced by cutting them across where they are bent, *i.e.* near the centre; this, however, is not advisable, for supposing that the belly is sufficiently wide that insoles could be cut across it, then fig. 108 illustrates the loss that is incurred; AB represents the cut across the belly; C the insole that fits up against AB; D is the insole which would fit against C if the leather was not cut across; the dotted line on the right-hand side of AB shows the portion of the insole as a result of the cut AB, and the shaded portion shows the amount of material lost. This insole pattern is in general use and the loss equals one-fifth of the area of an insole, the material being from the primest part of the belly; assuming that the

insoles are worth 2½d. per pair, then the loss on every 1000 bellies cut will nearly amount to £1.

If we consider the question of narrower bellies which are not wide enough to cut insoles on this principle, even then the loss is considerable, as can be seen by fig. 109, where the line AB represents the cut across the belly and the spaces marked from 1 to 6 show the six pieces of waste; if these insoles had been cut even in the same positions without first severing the belly into two pieces then the waste would have been in three pieces instead of in six, and would have been large enough to be useful for piece-lifting. If it is considered advisable to commence the belly at its centre the system shown in fig. 110 is a better method, since the waste between the insoles is considerably reduced, and in cutting the prime part of a belly even small economies are important.

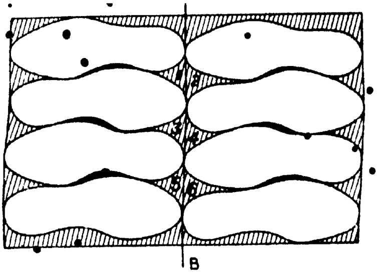

FIG. 109.

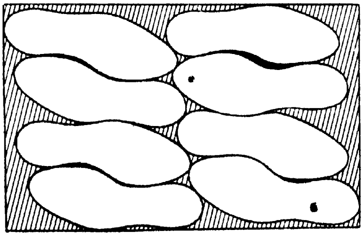

FIG. 110.

The question, however, still has to be considered as to whether it really is a wise plan to commence cutting a belly at its centre; although it must be admitted that if they are cut on the press while they are dry then it is much easier for the pressman to make them lie flat, but if they are mellowed this difficulty is disposed of and we may further consider the advisability of not cutting them across.

The value of leather depends primarily on its size; its suitability is secondary to its being large enough; as the size of the bellies decreases it becomes more and more difficult to use them without a larger percentage of waste; this being so is it advisable to commence a belly by cutting its finest part into two pieces? Supposing it is an average belly with 3 feet of prime material between the two weak places, then remembering that the fore shank is lighter than the hind shank and that the insoles have to be placed with their length in the direction of the length of the belly, it will be seen that unless it is when cutting the smaller sizes of ladies' insoles, the ends of the second lot towards the light shank may be so poor and light that they have to be used for a lower quality, the value of the good portion of the insole having to be sacrificed because of the lack of uniformity.

It is not unusual to commence bellies by cutting off the shanks, and if this is intelligently done it is certainly a better method than cutting them across at the centre. In this case all that portion should be removed with the light shank which, for insoles, is not sufficiently good either in substance or quality, and in removing the hind shank only that which is unsuitable should be cut away, thus endeavouring fully to economize the best of the material.

Yet even the practice of cutting off the shanks cannot be recommended, since every time leather is reduced in size its value is decreased, because the difficulty of cutting it to the best advantage is increased; *e.g.* it is doubtful if anyone would undertake to prove that it is always possible to cut up the shanks that are cut off as easily, as quickly and as successfully as they could have been cut while still attached to the other part of the belly; possibly a more economical arrangement could have been used with an extra half an inch of material which would not have lessened the yield from the other part of the belly; therefore avoid cutting them into sections if suitable presses are available. When it is the practice for one pressman to cut the centre of the belly and another to cut up the shanks, one pressman cutting insoles and another cutting the stiffeners, then it is a good plan to commence as far back as possible n the light shank and work towards the hind shank. The belly is narrower at the light shank and there is less opportunity of varying the arrangement of the patterns, whereas several arrangements may be possible in the wider part of the leather.

For cutting insole bellies the principles may be tabulated as follows:—

(*a*) Insoles being more valuable than stiffeners, commence the belly where it will enable you to secure the greatest number of the former.

(*b*) Do not cut into a stiffener that which is good enough for an nsole if you can avoid it.

(*c*) If another man is to cut up the remainder (after the insoles are cut) then leave it in as useful a shape as you can.

(*d*) If scraps are unavoidable, endeavour to let them be useful in ize and shape.

(*e*) If waste cannot be prevented let it be out of the worst of the material.

(*f*) Do not cut lifts unless they are really needed, especially the small sizes.

292. Shoulders are classed or described according to the following details :—

(*a*) *Country of origin*, as English, Australian, or American.

(*b*) *The tanning agent*, as "English oak-bark," or "English tanned hemlock shoulders," "American hemlock shoulders," "Australian shoulders retanned with hemlock," or mangrove.

(*c*) *Their shape*. The cheeks may be left on or taken off; if taken off the shoulder would be described as being "squared".

The length varies between 18 and 36 inches, and they may be described as "short," "medium," or "long cut".

(*d*) *Method of finishing*. Shoulders are generally "pinned" or "struck" before they are put on the market, but they can often be purchased "unstruck". Sometimes the tanners level the shoulders but this is not usual. Welting shoulders are dressed with grease to make them more flexible and less likely to break away in wear.

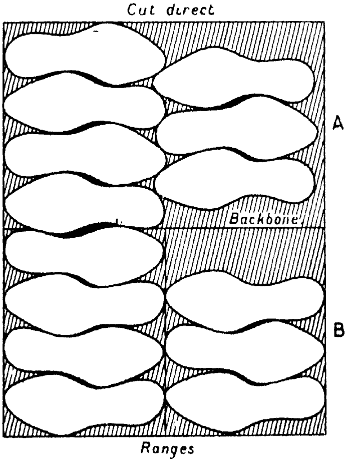

FIG. 111.

(*e*) *Their weight*. Shoulders vary in weight, being between 6 and 10 lb. each, and after being sorted they are described as "light," "medium," or "stout".

(*f*) *Their suitability*. Shoulders are used either for hand-sewn or machine-welted insoles for men's heavy boots; also for soles for cheap shoes, slippers and turnshoes. If very light and clean they may be used for fair-stitched middles.

Shoulders may be ranged or cut direct; the arguments in favour of the latter would be similar to those in favour of cutting bends direct. The arrangement of sole or insole patterns can be seen by referring to fig. 111, but fig. 85 indicates how quality and substance vary in shoulders. The parts marked A and B are always much thinner than the rest; C and D being the part which comes at the throat, is always the stoutest and has the longest fibre; E and F are just a little stouter than AB, but not as stout as the other parts of the shoulder; KK are always light. Along the backbone the fibre is very short and usually too brittle for either handsewn or welted insoles, it is also somewhat lighter in substance and often badly marked.

Shoulders should be commenced at the backbone, whether cut direct or ranged, and the inside joint should be put next to the backbone as shown in fig. 111 and explained in § 282. The second row may be taken either as at A or B (fig. 111); it is not advisable to put the toes of soles at L (fig. 85) since this is generally weak; C and D are also weak, and even if the arrangement appeared economical yet it would be better to let these parts come in the heel. Rules cannot be laid down for the systematic cutting of the remainder of the shoulder, since this will depend entirely upon what is required and the suitability of the material.

CHAPTER XXV.

LIFTING.

293. THE heels of boots (unless they are made of wood) are built up of several thicknesses. The ideal leather lift should be light in weight and close in texture. It is immaterial whether it has much or little nature in its fibre, whether it is pliable or liable to crack with each attempt at bending, or whether it has a perfect or damaged grain; therefore a cheap class of leather, which may be acid tanned, can be used; but manufacturers often find that they have a sufficient quantity of lifting that has been cut from the ends of the ranges or been worked in by the pressmen who cut the bellies, rendering purchases of special material unnecessary, except for men's work.

In cutting leather into lifts it should be remembered that:—

(*a*) Heels are never built higher in the front than at the back, but they are often built higher at the back than in the front; hence if it can be avoided, the stoutest part of the material should not be put in the front of the heel.

(*b*) Both sides of a heel must be alike in height, and because of this (if it can be avoided) lifts should not be cut with one side stouter than the other.

(*c*) Should the leather not be uniform in its quality, the weakest part should be put in the front of the lift, since it will then be less likely to make the finishing of the heel difficult.

(*d*) When there is much flesh on the leather it should be split away as its presence makes the production of perfect heels quite impossible.

294. When all the whole lifts have been cut from the leather there will still be pieces which can be used for sectional lifts. They should be designed as similar as is possible both in shape and in size to the waste pieces made in your own press-room, always remembering that the fewer number of joins which appear in the edge of the finished heel the easier will be the finisher's task, and that it is also easier to make a good join when the sections meet at right angles to the outline of the lift.

In fig. 112 several designs are shown for using up pieces. Those in the first row only show one join in the finished heel; the first two are formed with only two pieces in each lift, but the other two have three pieces in each lift, although they only show one join in the finished heel. The first two designs in the second row are each formed of two pieces and show two joins, but with the last two designs in the row, although each is made of three pieces, yet only two joins appear in the finished heel. The designs in the third row have each three joins to show in the finished heel; the first is made with three pieces and the other two with four pieces. Four-piece lifts are not often used unless the lifts are of large size.

Should it be desired to use more than one joined lift in a heel it would be an advantage if the sections of the next lift were a different shape, otherwise both joins being in the same place it would be difficult to make a solid heel, consequently if the lifts are so designed that by reversing them the join does not come immediately above the previous one this must be an advantage; hence the second design of the first row is better than the first, since when reversed the sections would meet where the dotted line is shown and nails put in at the crosses would pass through each of the pieces and ensure solidity. From the foregoing we conclude that on the first row the fourth design is better than the third, and that on the second row the second is better than the first.

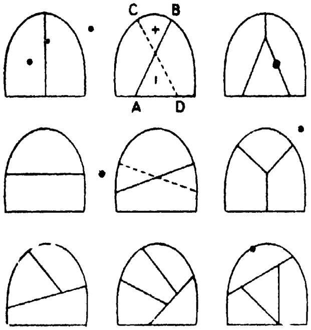

FIG. 112.

Two styles of seam are used in pieced lift heels. That which is generally used is a square join, the pieces being placed with their square edges side by side. There is only one objection to this method, and that is that if the pieces are not fitted close together, no amount of compression can correct it. The second style is the flange join (fig. 113), where both edges are bevelled at the same angle; therefore they make a perfect seam, and if the join is badly made through carelessness it does not spoil the heel, since by compressing the heel the sections are made to fit close together. The arguments against it are that it requires more material because of the bevelling of the edges, and there is the extra cost of bevelling the

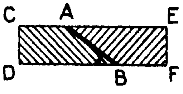

FIG. 113.

pieces, but even then it pays to use this join on good-class men's work where the ordinary pieced lift heel would not be accepted.

Sectional lifts may be cut in either of the following ways:—

(*a*) An ordinary eccentric press may be used.

(*b*) Knives may be fixed to a plate which is then fastened to a bench, the edge of the knives being upward. The pieces of leather are placed on the upturned edges of these knives, being then cut with a mallet made of wood; it is important that the mallet be kept in good shape. The cut sections fall through into the separate compartments which are arranged to receive them.

(*c*) A revolution press may be used, similar in design to an "Ideal" clicking press; it has a swinging arm and a hand lever to control its motion. The knives with their edges turned upward are fixed in a curved row to the bed of the machine; the operator then places the pieces in position, swings the arm round over each of the knives in turn and depresses the lever.

We may contrast the three methods as follows:—

The first involves an unnecessary waste of power, because the engine has to drive an ordinary press when only a little work is required. There is also a considerable loss of time through picking up and putting down the different knives.

The second saves the cost of power, but the process is very slow and the shape of the edges is usually not good, since the blow from the mallet seldom falls perpendicularly. When the edges are not cut square the making of good heels is well-nigh impossible.

The third is quick, because the knives are always in position and since the piece is always cut with the first blow (with the hand mallet it is not), and as it falls perpendicularly the edges are in better shape. The machine does not require much power.

295. Leather is the most expensive material used for building heels, and the only material considered satisfactory under all conditions. For many years wood heels have been popular where lightness in weight is important; they may be finished with pad and brush, or they may be covered with fabric, leather, or celluloid. Leather-covered heels may, before covering, have the leather cover stitched by machine to imitate hand work, and celluloid covered heels may be printed with an imitation stitch. The "Vik" heel is without doubt an improvement on ordinary wood heels, since it banishes the probability of the heel splitting either when being attached to the shoe or in wear; its peculiar feature is a saw cut made in the heel near the seat and parallel to it, this is filled with a thin piece of wood the grain of which is placed in a direction transverse to that in the heel. Wood pulp has, however, somewhat reduced the demand for wood heels, since it is easier to attach and when attached is more secure. It may be purchased in sheets of varying thickness; there are different qualities and these vary in degrees of hardness and difficulty of working. It should be solid enough to be capable of receiving a high surface polish, but not so hard that it is difficult to remove the marks of the coarse abrasive used in scouring the heel.

"Leather layers" were formerly used for building heels (previous to the advent of wood pulp), but the paste used in its manufacture made it difficult to obtain a satisfactory finish.

296. Whatever material is used in the heel it is advisable to provide some means of making the bottom sufficiently concave that it will fit on the heel of the last (§ 27). This may be secured with a bevelled strip of leather, similar in cross-section to the figure ACDB, fig. 113. The method is to select some suitable material sufficiently mellow that it can be "turned," this is ranged, the width of the range being equal to the length of the "rand" required; these strips are then cut as in fig. 113, when ABDC forms one rand and ABFE another; a machine being used which has two knives, one of which makes the cut at AB and the other the cut at EF. In some factories considerable economy is effected by using the scarf taken from stout stiffenings, this is machined (in the upper-closing department) to one of the bottom lifts, a long stitch being used; if it is not quicker it is certainly more satisfactory than nails. On the heels of some ladies' boots the seat of the heel is worked very thin, and the probability would be that in shaving the heel the nails used for attaching an ordinary rand would be cut into, under these circumstances a "gouged" lift is used, the method being as follows: A lift suitable in size is placed in a machine and bent in a manner similar to what it would be if attached to the curved seat of a last, a flat knife then passes over the lift and removes the raised portion; this is the best method of making the seat level when the heel-attaching nails could not be relied upon to pass through and secure an ordinary rand.

Occasionally piece lifts are used, like the second in the first row, fig. 112, the edges AB and CD are bevelled and lapped at the back; small pieces of leather are by this method utilized and the heels would be satisfactory if either the building or attaching nails secured the sections.

When the leather which is being used is not sufficiently mellow for turning, and sectional lifts are not approved of, then a horse-shoe lift may be used. If the heels are built of a leather substitute and a rand is used this would be the form selected.

When heels are being built for lasts that are full in the waist—like Court shoe lasts—then the heels must be made much higher at the back than at the front, under which circumstances a "wedge lift" would be used. From suitable material cut a strip of leather sufficiently wide, then split it on the principle shown in fig. 113, after which lifts may be cut from it, putting the stout side of the material to the back of the lift,

CHAPTER XXVI.

FITTING UP.

297. ASSUMING that the different sections have been cut they must now be selected according to their suitability for different purposes.

The sole is the most expensive part of the bottom, and is subject to the greatest strain; therefore in its selection considerable care and judgment are required. The method adopted for the sorting of the soles in any factory will be determined by its class of trade.

If a manufacturer only makes one quality shoe then it will not be necessary to sort the soles into several qualities. The sorter in this case can only do one thing, *i.e.* examine the soles to see that they are not too poor to be used. If, however, the manufacturer does two or three classes of work, as sewrounds, Blake-sewn and riveted work, but does not make many lines in each class, then separate material may be purchased for each line and the sorting will practically be as in the first case. But it is not unusual in England for a single manufacturer to make ladies', men's and children's goods, and to attempt anything between ladies' slippers and men's shooting boots. In such a circumstance the buyer of the material should know exactly what *could* be used and what *ought* to be used for each line.

In the manufacture of boots and shoes five things may be kept in view: (1) appearance; (2) flexibility; (3) lightness; (4) utility; (5) cost; and if to either of these undue importance is attached then the others must suffer in consequence. For example, if cost is considered to be most important then utility and appearance may suffer; but if utility is treated as the principal consideration then each of the other points—cost, appearance, or lightness—become comparatively speaking less important. But supposing that each point receives its just share of attention, then in buying material for the soles of boots we should endeavour to maintain as far as possible the character of each attachment.

In those styles which are not ideal styles but which are used because considerations of cost prevent the employment of the better, the character aimed at should be that of the ideal method. For example:—

Screwed boots are designed for utility, for hard wear, often under damp conditions, a channel being sometimes used. The tannage therefore should be sufficiently mellow that the channel can be cut and opened, and the leather selected should not become sodden when it is wet, but be able to endure the grinding action of walking. When the boots are repaired by another method of attachment they will not be quite as efficient, therefore the leather selected should be sufficiently good that they will not quickly require repairing, but appearance, flexibility and lightness may often be ignored and sometimes cost also when the goods are designed for utility. Riveted boots are not made on an ideal method; the screwed boot is the best in metal attachments, and if boots did not cost more when made this way then probably no one would accept a riveted boot,—they would demand the ideal method.

The *riveted boot* is designed for utility, and as a channel is not used the leather need not be quite as mellow on the grain as is necessary for the screwed boot. The attachment is by nature rigid; people do not, however, wish the boot to be rigid—they merely endure this to avoid extra expense. It is possible to use leather in the soles of riveted boots that could not be used in any other style of manufacture, but service should be aimed at as far as cost will permit.

In *thread attachments* the hand-sewn is the ideal; it is the most serviceable and the most comfortable, bending easily with the movements of the foot. The sewing is sunk into a channel and being an expensive method of attachment the appearance of the finished shoe is studied. The leather selected should therefore be clean so that it can be finished, flexible so as to maintain the character of the attachment, and have considerable nature in its fibre to avoid the sole being cut through by the shortness of the stitch. Utility is important, while cost is generally a minor consideration.

With plants of welting machinery many boots are made on the hand-sewn principle to avoid the expense of hand labour, but although so much importance is attached to cost yet as far as it is possible the character of the method of attachment should be maintained, *viz.* flexibility, and on account of the cost of repairing, utility should not be ignored. The style of finish is often altered to enable the manufacturer to use less expensive leather.

The veldtschoen is a substitute for the ideal method—the hand-sewn—and the selection of the sole should (as far as cost will permit) be the same as for hand-sewn. The shoe being difficult to repair, a serviceable sole should be used.

Blake-sewn (*McKay*) is not an ideal method; it was designed to enable sewn boots to be put on the market at a less cost than hand-sewn boots, but they are not as flexible, not as comfortable, and far less serviceable than hand-sewn boots, therefore it is certain that no one would have their boots made by this method if they could have hand-sewn boots at the same price. This being so, the character of the ideal method should as far as possible be maintained, but since cost is important the question should be considered, as to how the character can be maintained and yet reduce the cost. Remembering that there will not be used as many stitches to an inch as would be in attaching the sole of the hand or machine-welted boot, a saving in cost can be effected by using leather of a less expensive tannage, because less nature will be necessary in its fibre. The relative importance that may be attached to each of the points—flexibility, appearance, utility, and cost—must be determined when designing the particular boot.

The *sewround* is an ideal method of attachment. Its great feature is that shoes can be made in this way with less weight in the bottoms than by any other method. As a rule the shoes are only worn indoors, they will therefore not be worn under damp conditions and there will be but little strain on the soles.

The leather must be very flexible, so that the shoes can be turned after they are sewn, there must also be a considerable amount of nature left in the fibre, so that it does not break away with the horizontal seam, more nature being required for this than for a vertical seam. Where sewround shoes are designed for outdoor wear the soles should be the best obtainable, because of the difficulty of repairing them.

Pegged boots form a distinct type; they are useful for wearing under very wet conditions, as for fishing or farm boots. The method is not used for light work where flexibility is important; appearance is only secondary, but ability to endure a soaking without becoming sodden and to withstand hard wear are essential characteristics.

298. There are two methods by which a manufacturer may obtain a sufficient quantity of soles to meet his requirements.

He may purchase the soles already cut from firms who cut and sort material for this purpose, and undertake to supply any quantity of soles which shall all be uniform in quality and substance; in some circumstances it is the better plan to buy these soles rather than to attempt to cut them. For example, if the trade is confined to one quality of shoe and that shoe requires a good selection of sole, then inferior soles would either have to be used or be allowed to accumulate, since it is not possible to buy leather that produces only one quality of sole. The firms, however, who supply these cut soles can find a market for all the qualities which they may cut, and therefore they can usually supply a large quantity of soles of any specified description at a lower price than they could be cut by the manufacturer who only has a use for one particular quality. But uniformity of substance and quality are not the only things secured; uniformity of cost is also ensured, and when a shoe is offered for sale at only a very small margin over its actual cost, it is a comfort to the manufacturer to know that he can be at ease as to the cost of one of the most expensive parts.

If the manufacturer cuts his own sole-leather, then he will endeavour to find a market for such lines as will enable him to dispose of the soles which are cut from the material. Supposing, for example, that a quantity of soles has been cut all from one sort of leather, and that the leather was mellowed and rolled. The soles should now be sorted for substance, the gauge being stamped on the heel part of each sole. There are many machines in the market for this purpose, the best known being "Nichols' evening and grading machine"; it automatically adjusts itself to the substance of the sole, corrects any inequality in thickness and stamps its gauge on the seat of the sole. Very few men could sort soles to $\frac{1}{48}$ inch, even if they were not restricted to time, while the few who might succeed in doing it are worth too much to be employed doing that which a lad could do just as well with the aid of a reliable machine. Should the volume of trade not be sufficient to justify using the machine named then less expensive machines may be used, such as the "Fahnley" sole gauge which measures and indicates the thickness of insoles, middle-soles or soles even to $\frac{1}{48}$ or $\frac{1}{96}$ of an inch.

When the soles have been separated into substances, then each substance may be sorted into several qualities (see chap. xx.). If there are four substances and each substance is sorted into three qualities this would give twelve selections of soles. It is not unusual for a manufacturer to use two or three distinct kinds of leather: for example, he may use American sides for riveted goods; union for medium quality ladies' work, and combination oak and valonia for ladies' golf boots, each class of leather being sorted as already described.

When the bottom-stock ticket reaches the one who has to select the soles it should indicate what class of leather is to be used, what substance, and what quality.

There are many factories where machines are not kept for determining the substance of the leather, and therefore different principles will govern the sorting. Some manufacturers only purchase one brand of sole leather, but others purchase odd parcels which may differ both in tannage and quality; under such circumstances it is usual to "*sort by judgment*" and endeavour as far as possible to select the soles for each class, so that there shall be *uniformity of wearing power*; where the quality is lower, this may then be balanced by giving greater substance. The method being less mechanical, more skill and judgment are required in the sorting.

Sometimes (principally in the heavy trade) soles are sorted by weight and described by the weight per dozen pairs; this does not appear to be satisfactory, since there must be considerable difference between the weight of the large sizes and that of the small ones, therefore if several dozens were selected the proportion of large sizes being greater than usual, and the weight per dozen is strictly adhered to, then the soles must be selected lighter in substance. It would seem to be a fairer method to select the soles according to gauge and quality. The reason why more attention is not paid to quality is that the soles will be specially nailed, hence they will not be subjected to much wear.

299. For selecting the insoles, the character of the material required by each attachment is already given in § 263, but there still remain some important general observations.

Efficiency. The insole is the foundation of the boot; the sole may be out of the very best material, but what advantage is this if the insole is deficient? When the sole is worn through it can with more or less ease be repaired, but a faulty insole renders the boot inefficient even while the sole is in good condition; yet it cannot be remedied unless the boot is entirely remade, therefore in selecting insoles for either screwed, riveted or welted boots great care should be exercised to ensure efficiency.

The strain is not uniform for all boots; *e.g.* the insole of a little child's shoe made with a riveted thin single sole, will not have to bear the same amount of strain as a man's split boot with nailed forepart; the strength required in the insoles to enable the laster to last the toes of the two shoes will be very different; and this must not be overlooked, since it will often indicate when the weaker insoles may be used without in any way impairing the efficiency of the shoe.

The character of the attachment should be maintained, as far as possible. Supposing, for example, that a wide range of goods is made, including riveted and Blake-sewn. Different material may be purchased for the insoles, some being mellow and some harsh. The mellow insoles should be used for the sewn, to maintain the character of the attachment, and the harsh insoles should be used for the riveted boots where a lack of flexibility will not be a serious defect.

Economy of material is very important. For the selecting of the soles this has been referred to, although it is hardly possible to use material in the soles of boots which is too good, unless it is by using soles so good that they outwear the uppers, but this is not likely to occur, unless the latter are cut from Persians or fabrics. It is different, however, with the insoles, for they may be used better than is necessary and no useful purpose be served by the excess of value; on the contrary it may reduce the special features of the attachment. For example, one of the desirable characteristics of a Blake-sewn boot is flexibility and another is lightness, but if insoles are used which are stouter than necessary then the weight is unduly increased and the flexibility impaired. The sorter should endeavour by actual experience to ascertain what would be an ideal insole for each different class of work, and then sort to that standard, since economy of material means a save of money, and even one penny per dozen saved on the insoles is a save of £2 on 500 dozen; yet often much more than this could be saved without decreasing in the least the value of the shoe. For Blake-sewn, if the insole is strong enough that the toe and seat of the shoe can be properly lasted in, then it is quite strong enough to hold the rest of the bottom.

For welted insoles see § 361.

300. Many of the details concerning the stiffener will be found in § 265, but the method of sorting has not been described. Supposing that a quantity of them have to be sorted, then each should be handled to test its resistance to being flexed; this can be done with practice by the thumb and fingers with remarkable rapidity. Some, although stout, may be a little weak in resisting power, and should be passed through the roller, for if they were cut while the leather was mellow they should be in suitable temper, but it would be useless to roll leather that is dry. Some of the stiffeners may be unlevel and should be put through either the evening or splitting machine (§ 314). They may now be sorted into substances for which the "Tria" is a suitable machine. It saves material since it prevents stout stiffeners being used where lighter ones would do. It is a common occurrence for stiffeners to be used much stouter than is necessary; but why add unnecessary weight to a boot, or make the heel part so hard that it is less comfortable than

it ought to be? Why give away even a fraction of value that does not improve the boot? These possible economies should be studied even though small; otherwise, for mere want of attention, money may be lost. The "Tria" also affects an economy of time, since it is quicker and more accurate than the most skilful sorter; the makers claim that 12,000 pairs of soles, insoles, or stiffeners may be sorted in one day, since the machine automatically places them in different boxes according to their substance.

In selecting the stiffener for any particular boot or shoe the following points should be considered:—

(*a*) The shape required by that design of upper; a straight golosh would generally have a shallow stiffener cut straight at the top, otherwise, when possible, the shape should be that shown in fig. 47.

(*b*) The size necessary for that size boot.

(*c*) The strain that may be put upon it in the process of manufacture; boots removed from the lasts many times and often relasted before the stiffeners are dry will require stronger stiffeners than those boots which remain on the lasts until they are finished, by which time the stiffeners would be quite dry.

(*d*) The resisting power of the stiffener must be suitable for the upper (§ 265).

(*e*) The strain it is likely to have in wear will vary with the class of footwear; it will be very little in a Court shoe, whereas a shooting or golf boot will have a stout upper and in addition may often be wetted.

301. The sorting of middle-soles should begin with looking them through to see if any need to be levelled (§ 314) or rolled, after which it is the most economical method to put them through a gauge, the substance being stamped on each piece; they should then be stored according to their gauge. It is admitted that this will take up room, but the sorter's time costs more than rent. If they are only stored in sizes, irrespective of substance, and the sorter has to select from the bin, say three dozen all to be the same substance, he may have to handle very many before he can find the quantity he requires, and for his next ticket he must again search perhaps for a different substance, and thus some pieces may be handled many times before they are used, whereas when sorted by machinery and stored in gauges they only require to be handled once. But supposing that it is not easy to find the required number that are suitable, the sorter may use the nearest substance, and now he will have to choose one of two courses, either to use them as they are, or put them through the evening machine to make them the desired substance; if used as they are then the finisher will have to do extra work, since some of the edges may be too stout, the boots will also be unnecessarily heavy, and consequently unsatisfactory; it is better therefore that the middle-soles should be put through the splitting machine, since the substance would then be satisfactory, the excess value of the material being lost in either case. Since in the settling of accounts even the discounts are very closely watched—and rightly so—there should certainly be the same care with each detail in the boot. In America middle-soles are usually described by the total thickness of 36,

48 or 60 pairs when put in a pile. Middle-soles for fair-stitched work should be clean on the face, because they cannot be cleaned by ploughing, and those selected for any one lot of work should also be out of one sort of material, otherwise the welts will vary in colour. In the selection of the bottom-stock for work the edges of which are to be finished a natural colour, it is very desirable that the sole, middle-sole and lifting should be from leather all of one tannage, otherwise it will not be easy for the finisher to obtain a uniform colour in the edges.

When middle-soles have been cut from material that is very much damaged on the grain side, then it will be difficult for the finisher to finish the welt satisfactorily as regards the impressions of the fudge wheel; they should therefore be put through the evening machine and the damaged face split away.

302. Sometimes the ticket which is given to the sorter, will specify the gauge both of the sole and the middle-sole that are to be used, but other firms specify the required substance of the finished edge. In the first case the sorter has no responsibility, except to follow the instructions; it is not so in the second case, however, since the substance that the edge will be when it is finished differs from its substance when it leaves the fitter-up. The substance of the finished edge may be indicated by fractions of an inch, as $\frac{1}{4}$ inch, $\frac{3}{16}$ inch, or $\frac{1}{2}$ inch; or it may be specified by a number, as number 9, 10, or 11 edge; in the latter case the numbers signify so many $\frac{1}{48}$ of an inch, number 9 therefore means $\frac{9}{48}$ of an inch; but in the preparation of an edge the welt is ploughed out at an angle (§ 393), and this will reduce the substance of the edge; the face of the sole will also be bevelled by the sole-guard of the iron, also causing a reduction in the substance; the iron used for setting may have a "jigger" which will further reduce the substance of the finished edge. The actual amount which it will be necessary to allow for these decreases in substance will depend upon:—

(*a*) *The angle of the welt.* This may vary between 26° and 45°, and the greater the angle the greater must be the amount allowed for reduction.

(*b*) *The width of the welt.* Whatever the angle may be the amount by which the edge is actually reduced in substance will depend upon the width of the welt; the apex of the angle is by the upper, but the further the edge is from the apex the greater will be the reduction.

(*c*) *The shape of the iron.* Whether it has or has not a "jigger," and the angle of the sole-guard.

(*d*) *The nature of the leather being used.* Some leather needs to be compressed to obtain a solid edge, but other leather is so hard that it can only be set by using a larger iron.

Therefore the fitting-up department should keep in touch with the finishing-room foreman, since the allowance required is not always the same; generally speaking $\frac{1}{48}$ inch will be required for ploughing, $\frac{1}{48}$ inch for the jigger and $\frac{1}{48}$ inch for compression, but if the leather is inclined to be soft or open an extra $\frac{1}{48}$ inch must be allowed for compression (§ 395).

CHAPTER XXVII.

THE PRINCIPLES OF COSTING BOTTOM-STOCK.

303. BEFORE proceeding to describe the method of costing bottom-stock we must first notice those general principles which should form the basis of our calculations and influence our conclusions.

(*a*) It is possible to buy—already cut and sorted—each of the pieces of material used in bottoming the boot, such as stiffeners, insoles or lifts; supposing that we cut these parts, then we are working at a loss, unless we can produce them at a similar rate; hence in costing we must assign as the value of the parts—insoles, stiffeners, etc.—the price at which we could obtain them (or substitutes of equal utility) in the open market.

(*b*) Middle-soles, for example, may be cut by the boot manufacturer or purchased already cut; the weak ends of ranges from which soles have been cut may be used, or the shoulder end of butts, or bends where the material is too poor for this particular manufacturer to use it for soles; they must not however be valued on the basis of the first cost of the material but on the basis of what they could be produced at if suitable material were specially purchased; if suitable middle-soles could be cut from firm bellies (in sufficient quantity) then these must form the basis for valuing, since the manufacturer will not receive a higher price for the shoe, even though he cut them from the purest bark-tanned butts; *therefore we must assign to our cut parts the value of the cheapest material that could be used in producing a shoe of the same market price.*

(*c*) It is obvious that if a manufacturer cuts up a great number of lifts, say more in fact than he can use, then he is working at a loss, since the only value of those products to him is what he may be able to obtain for them in open market, which price is naturally lower than that demanded by a firm which specializes in cutting for the trade.

(*d*) In the case of a manufacturer producing only one quality shoe, it is clear that he only requires one quality of stiffening, insole or sole, but he will doubtless have a number of superior worth, yet as far as he is concerned they are not worth any more, since they do not enhance the value of his particular line; on the other hand, these superior pieces would be of higher value to a man running a line which really requires them.

304. From the foregoing it appears that it is often cheaper not to

cut for one's self, but to buy just what is required from firms that specialize in these lines. Heels already made can be purchased at a price lower than that at which the boot manufacturer formerly costed them; two factors combined make this possible: (1) The heel manufacturer can often purchase boot manufacturers' offal at a very low price. (2) Heel manufacturers can use a class of leather which in the ordinary way boot manufacturers would not purchase,—leather that is damaged on the grain, or acid-tanned and too brittle for any other purpose. In wear these heels answer very well, and since the boot manufacturer can use them and still obtain the same price for his shoes, it must follow that if he continues to make his own heels, and they cost him more than the price at which he could purchase them, then the difference between the cost of heels built by himself and those he could purchase is *needlessly lost.*

There is also another consideration: many substitutes for solid leather are used in building heels, such as wood pulp or leather board, and for some classes of wear—*e.g.* canvas shoes—these are quite as satisfactory as solid leather, and if we cannot obtain a higher price for our shoe even though a solid leather heel is used in place of one of these substitutes, then the value of the substitute determines the value to us of the leather heel. From the foregoing therefore we conclude that the value to us of our cut lifting will depend upon:—

(1) The price at which we could purchase suitable lifting.

(2) Whether we could use a cheaper substitute.

(3) If our supply exceeds our need, it will only be worth what we could obtain for it.

305. Similar arguments to the foregoing apply to stiffeners, since:—

(1) They can be purchased already cut, skived, and moulded, and unless those which we cut are superior in some detail then they cannot be worth more than those we could purchase.

(2) If for some reason our supply exceeds our demands, then notwithstanding our higher estimated value our surplus is only worth that which we could obtain for them.

(3) Sometimes a substitute for leather is not objected to—for example, a cheap canvas shoe; possibly the buyer of the shoe would not pay one farthing more for a leather stiffener; under such circumstances if they are used we are selling them at the value of the substitute which we might have used.

306. The value of insoles will be determined by:—

(1) The price at which we could purchase them, unless we can cut them at a lower price.

(2) If you do not produce as many as you require of a particular quality, and you are obliged to purchase some, then those you cut are worth as much as those you purchase.

(3) Whether a substitute could be used which would cost less and yet not lower the commercial value of the shoe.

307. If we accept the foregoing principles then the costing of any particular lot of leather is very simple. We will illustrate the method by

an actual costing of bellies. The price will indicate that it is not a recent purchase, but this will not affect the method of costing.

(*a*) Find the cost of the material that is 122 lb. at 6⅜d. per pound.

(*b*) Find the value of the items which have fixed values such as piece lifts and whole lifts; stiffeners may also be included, seeing that it is easy to obtain a quotation from the firms that are prepared to supply them already skived and moulded, and we may find that it is advisable to purchase them.

(*c*) When *b* has been subtracted from *a* the balance of the cost must be met by the other things which have been cut from the material.

(*d*) If in practice it is found that those costings work out best that have the largest proportion of stiffeners, then it can safely be concluded that the amount allowed for them is too much, even though it may be less than the price at which they could be purchased.

308. The cutter is not always responsible for the loss or gain shown by the costings, because the sorting is often determined more by the boot manufacturer's needs than by the actual merit of the material. If the demand for the best insoles is very small then the sorter can work to a very high standard, but if there is a large demand, then a sufficient supply must, if possible, be secured or special leather obtained. If special leather has to be purchased the amount which the insoles then cost must be the price at which to cost them in the present sheet.

It may be that there is little demand for the poorest grade of the insoles and that to dispose of the line at all it must be offered at a very low price as a job line. In this case orders would only be accepted for the quantity unavoidably produced, and *these insoles may be costed at a price lower than that at which they could be produced in the ordinary way, or in quantities.* It is often said that "each part must be costed at a price at which great quantities could be produced separately if necessary"; obviously this requires some qualification, since while it would unquestionably be true of regular lines, it would not be true of by-products, unavoidably and not designedly produced; these must be disposed of at any price obtainable in the market, and the nearness of this price to the cost of the material will depend upon the demand of the market. The value of piece-lifting, for example, is dependent upon the willingness of the public to accept goods with such lifts. If they entirely banned them then piece-lifts would have no market value, but no one would think of costing them at a price which would enable them to be produced *ad libitum* since they are only a by-product.

In this case, having fixed the price of the best quality as already explained, and having 158 pairs of women's insoles still to value, sixty pairs of which are inferior in quality, we proceed as follows:—

To make the costing pay we must get 16s. for the 158 pairs; if they were of uniform quality we should put them at the *average cost*, and at 1s. 2½d. per dozen we should have 15s. 11d., but sixty pairs are too poor, therefore we offer them at 1s. 2d. per dozen, this being 5s. 10d. for the sixty pairs; we now have ninety-eight pairs of insoles for which we must obtain at least 10s. 2d.; at 1s. 3d. per dozen the amount would be 10s. 2½d. and the costing is just clear.

But supposing that we have a difficulty in disposing of the inferior insoles, we may find it necessary to reduce the price to 1s. per dozen. We now have ninety-eight pairs of insoles for which we must obtain 11s., hence the price must be 1s. 4¼d. per dozen. The sorter should realize that every insole which he puts into the class lower than the average quality will make it so much worse for the costing, and every insole which he can honestly place in the superior class is a distinct gain.

Probably few sorters realize the extent to which the financial success of the firm can be made or marred by their work, and it is highly probable that it is not fully appreciated even by all manufacturers. In the sorting of the upper leather there is not so much risk of lack of exactness, since the material is never out of sight; therefore the buyer of the goods can see that he does not accept inferior quality, and the quality inspector at the factory will endeavour to prevent goods being sent out better than the sample, but it is not so easy to check the bottom-stock, since the laster is not likely to complain if either the insoles or stiffenings are superior to those used in the sample, and when they are in the boot who can determine their quality?

309. But supposing that there is a demand for this poor quality insole? In that case do not sort into it any that can be used for the better quality, but if it is possible to procure material that will yield a larger number of this selection and the costing still pay, then this course should be taken, but if the costing does not pay then it will be evident that the allowance for them must be increased.

In the costing of the smaller sizes, 7 to 10 and 11 to 1, the relation of their weight to that of the women's sizes may be a sufficient guide to the price. The difference will generally be in the proportion of 7, 9, 10, for sizes 7 to 10, 11 to 1, 2 to 7, respectively. The reason why the difference is greater between 7 to 10 and 11 to 1 than between 11 to 1 and 2 to 7 is because the amount which is added to size 7 to produce size 8 is equal to a larger proportion of the size 7 than is the proportion of the amount which has to be added to size 1 to produce size 2; this can be easily tested with the scales.

310. Shoes are sold at a price per pair, and in fixing the price of the shoe the cost of a pair of stiffeners must be added; when things have to be sold by tale, the most accurate way of determining the value of a quantity must be by their number not by their weight; therefore after being graded the stiffeners should be credited on the costing sheet at the price per dozen for each quality since it avoids inaccuracy.

For a similar reason middle soles should be costed per pair or per dozen, and in a range of prices according to their substance; they may also be further classed according to that for which they are suitable, as rivet, McKay-sewn, or fair-stitch.

SOLE-LEATHER DEPARTMENT.

Lot No. 591. *Cutter*.............. *Date*..............
Material. Bellies.
From A & Co.

				£	s.	d.
Weight issued. 122 lb. *@ per lb.* 6⅜d. *Value*				3	4	9¾
	£	s.	d.			
Value of cut stuff	3	7	0¼			
Value of stuff returned	—	—	—			
Per cent of waste ·237						
Total	3	7	0¼			
Profit or ~~Loss~~				—	2	2½

DETAILS.

Pairs.	Description.	Quality.	Gauge.	Weight. Lb.	Weight. Oz	Per Lb.	Per Doz s.	Per Doz d.	£	s.	d.
65	2/7 Insoles	1st		9	7		1	6		8	1½
98	2/7 ,,	2nds		14	2		1	3		10	2½
60	2/7 ,,	3rds		7	14		1	2		5	10
16	0/10 ,,			3	15½		2	3		3	0
18	11/1 ,,			2	6		1	2		1	9
15	7/10 ,,			1	8		1	0		1	3
4	4/6 ,,				3½			6			2
196	2/7 Stiffeners	2nds		18	12			9¼		12	7¼
47	2/7 ,,	3rds		3	7			8		2	7¼
12	0/10 ,,			1	15		1	3		1	3
33	11/1 ,,			2	6			7¼		1	8
14	7/10 ,,				14			6			7
4	4/6 ,,				3			5			2
27	2/7 Middle-soles			2	10½		1	0		2	3
	Lifting			23	5½	8d.				15	6¾
		Total		93	1				3	7	0¼

311. In the costing of bends we commence as we did with the costing of the belly, by filling in the value of those items which we could have cut from other material, or could have purchased, the value of which we therefore know; this includes lifts, half-lifts, possibly top-pieces, and middle-soles. The prices which we allow for the remaining items, as in the sorting of the insoles, must depend upon circumstances, since it is doubtful if any lot of soles would be similarly sorted, using the same number of qualities and the same standard for each quality by any two manufacturers, and possibly not exactly alike by two sorters at the same factory; but the soles having been sorted into the qualities which suit the particular trade of the manufacturer, the next thing will be to place against each quality the price per pound which will be allowed for that quality. If more than one tannage of leather is used and some

of the soles from one lot can be used for some of the qualities of the other tannage, then the prices allowed for those qualities should always be uniform and no distinction made because of the material the soles are cut from. The costing must then be made to pay by altering (if necessary) the price of those soles which are cut from one material only.[1]

Having ascertained the price per pound for any quality, it will not be difficult to obtain the price per dozen for each gauge; for example: if the soles in number 10 gauge average 5 lb. 3 oz. per dozen pairs, and the value is 2s. 2d. per pound, then 11s. 3d. will be the price per dozen pairs of that quality and gauge, and each different gauge and quality must be worked out in the same way.

By this method a standard tariff will soon be formulated and the costings will then be made out according to it. If each ticket shows a balance of a few pence then the tariff may be regarded as satisfactory, but supposing that some tickets show a profit and others a loss and that there did not appear to be any difference in the quality of the leather which was used, we should then compare that which had been cut; and if we found that in the tickets which did not pay there was a larger proportion than usual of any particular line, we should conclude that the price allowed on the tariff sheet was unsatisfactory; if, however, the tickets which showed a loss were costings of another kind of leather, then we should conclude that it would not be wise of us to purchase that leather, unless we could do so at a price as much lower as would be necessary to make the costing pay. Supposing, for example, in the costing given of the bend the price is altered to 1s. 8d. per pound, the total cost would now be £9 3s. 9d.; we cannot alter the value of the piece lifting, lifts or middle-soles, since they are only cut from material which cannot be used for anything else, and we could cut them from bellies which we will assume can still be purchased at the former price; the top-pieces may be cut from American side and thus avoid altering the price of these; we could also procure a different class of leather—perhaps a mellow tanned union side suitable for the thirds women's soles, and the girls' soles, but as we cannot find a substitute for the best and second soles we must use this leather and correct the tariff. The method would be as follows: Find the value of the items which could be cut from other material (those just mentioned), that is £2 0s. 2¼d., this leaves £7 3s. 6¾d. to be covered by the best and seconds soles; at the ordinary tariff this would yield £6 8s. 1½d., which would be a loss of 15s. 5¼d.; since this is equal to about 12 per cent (on £6 8s. 1½d.) we add that percentage to the price per lb. of the soles, the former of which now becomes 2s. 5d. and the latter 2s. 3d., but the soles being sold per dozen, the revised tariff based on the altered price per lb. will be, best soles 12s. 6d., 11s. 6d., 10s. 6d., 9s. 6d.; and the seconds 11s., 10s. 3d., 9s. 6d., 8s. 9d.; at which prices we realize £7 3s. 4½d. and the costing only shows a deficiency of 2¼d.

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[1] We are assuming that a tariff scale has not yet been set up.

SOLE-LEATHER DEPARTMENT.

Lot No.............. *Cutter*............. *Date*.............
Material. English Bend.
From...............

				£	s.	d.
Weight issued. 110 lb. 4 oz. Per lb. 1s. 6d. Value				8	5	4½
	£	s.	d.			
Value of the cut stuff	8	7	10½			
Value of the material returned			5¼			
Percentage of waste 12·245						
Total				8	8	3¾
Profit or ~~Loss~~					2	11¼

DETAILS.

Pairs.	Description.	Quality.	Gauge.	Lb	Oz	Per Lb.		Per Doz		£	s.	d.
						s.	d.	s.	d.			
18	Women's soles	1st		7	11	2	2	11	3		16	10½
42	,, ,,	1st		16	8	2	2	10	3	1	15	10½
12	,, ,,	1st		4	5	2	2	9	3		9	3
12	,, ,,	1st		3	15	2	2	8	6		8	6
12	,, ,,	2nds		5	1	2	0	10	0		10	0
30	,, ,,	2nds		11	10	2	0	9	3	1	3	1½
24	,, ,,	2nds		8	4	2	0	8	6		17	0
12	,, ,,	2nds		3	12	2	0	7	6		7	6
6	,, ,,	3rds		1	14	1	9	6	6		3	3
12	,, ,,	3rds		3	6	1	9	6	0		6	0
12	,, ,,	3rds		3	3	1	9	5	6		5	6
12	Girls 11 × 1 soles	2nds		3	0	1	8	5	0		5	0
18	,, 7 × 10 ,,	3rds		3	6	1	4	3	0		4	6
24	,, 7 × 10 ,,	4ths		4	8	1	2	2	6		5	0
12	Women's middle-soles			1	8		10	1	3		1	3
72	Women's top-pieces			2	13			1	0		6	0
	Lifts			4	14		8				3	3
	Piece lifting			7	2		¾					5¼
	Waste			13	8							
		Total		110	4					8	8	3¾

312. For the costing of sides it does not appear to be necessary to add anything to that which has been said. Those parts which have what may be described as fixed values (the lifting, possibly the stiffeners, also insoles and middle-soles, if these are sometimes cut from other material) must first be dealt with and the other parts will be costed as for the bend.

In the majority of factories one man will cut the soles from the sides, and others cut the remainder (§ 283) of the material; in that case the ticket may be designed as below.

SOLE-LEATHER DEPARTMENTS.

Lot No..... *Cutter*......... *Date*..............
Material..........
From............ *Date*.......
Weight issued....... Per lb.......... Value.......

Lbs.	Ozs	Per Lb.		£	s	d.	£	s.	d.
			Value of cut stuff						
			Shoulders returned						
			Bellies ,,						
			Cheeks ,,						
			Whole lifting ,,						
			Piece ,, ,,						
			Total						
			Profit or loss						

DETAILS OF CUT STUFF.

Pairs	Description.	Quality.	Gauge.	Lb.	Oz.	Per Lb.	Per Doz.	£	s.	d.

313. Many press-room foremen object to the wetting of leather previous to pressing because of the difficulty of afterwards costing the cu stuff; the difficulty may be reduced by using the following method The leather is weighed while it is dry and the total value obtained; th material is then wetted, mellowed and cut up, after which all the cu stuff and waste is carefully weighed; from the total weight now subtrac the first weight and then find the per cent which must be taken off t bring it to the first weight; for example, if it now weighs 100 lb., it previous weight 95 lb., then 5 per cent of its present weight is increase Should it be a costing of sole leather, the soles and middle-soles bein on the tariff at a price per dozen for each quality and gauge, then onl the weight of the lifting and waste will need correcting, and it must b conceded that the trouble of doing this is insignificant compared wit the benefits secured by mellowing the leather.

CHAPTER XXVIII.

BOTTOM-STOCK PREPARATION.

314. FORMERLY the different pieces of material used by the laster were given to him just as they were cut, the workmen being expected to do to hem, anything in the nature of preparation which might be necessary; but with the greater subdivision of labour this has been altered, and now everything that can be done to assist the subsequent operations is attended to in the fitting-up section of the Bottom-stock Department.

Not the least important of these operations is "levelling"; the substance of sole leather varies so suddenly that when it is cut up it could not be used in the manufacture of boots without spoiling them, unless it is first made level in substance; this refers especially to insoles, stiffeners, middle-soles and out-soles; should the operation be omitted or carelessly performed, the work of the finisher may be much more difficult than it need be through edges being in some places too stout and in others too light; while it must be very difficult for the fitter-up to decide for what substance he will use a middle-sole or out-sole when it is not uniform in thickness, hence they should be levelled immediately after pressing and they will then be quite ready to use should they be required in a hurry. There are several reasons why the operation should be performed in this department instead of by the laster; for example, when the latter does it, the work will be done by hand, which in this case cannot be considered equal to machine work; but even though for argument's sake it were conceded that it could be done as well, yet the time required almost precludes the possibility of undertaking it for wholesale manufacture; hence, being a process essential to successful manufacture, it is desirable that it be efficiently performed both at the most convenient time and by the cheapest method. The machine used is on the principle of a rolling machine in that the material is passed between two parallel cylinders, the lower one being slightly corrugated to assist the feeding; at the back of the lower roller a knife is fixed, its thickness being sufficient to ensure that it does not bend when in use.

315. Stiffeners require skiving, by which we mean the thickness of the edges must be considerably reduced. At the bottom edge this is necessary to facilitate the moulding and gathering in of the fullness; $\frac{1}{2}$ inch or $\frac{9}{16}$ inch will be the necessary width of the flange, according to the substance of the material. The top edge of the stiffener is skived because it prevents discomfort from the otherwise keen edge of the stiffener chafing the heel; in addition to this it considerably improves

the appearance of the shoe, since (if properly drafted) it prevents the outline of the stiffener being traceable through the upper; the reduction necessary to obtain this result will depend partly upon the substance of the stiffener and partly upon the nature of the upper, great care being desirable when the uppers are of light and soft material. Special care is necessary at the ends of the stiffeners, otherwise the upper at this place will appear to fall in; skiving the ends is especially important in welted work, since a sudden termination would cause the welt-seam to bulge out and seriously mar the graceful curves of the waist in the shaping of the sole.

The skiving should be done on the flesh side, because without weakening its resisting power the grain side can be reduced to a greater extent than the flesh could.

There are three distinct types of skiving machines in general use.

(*a*) In this class the stiffener is fed against the keen edge of a flat stationary knife, the angle of which is adjustable so that the width of the scarf can be regulated. The "Tandem" skiver has an ingenious device by which the stiffener is automatically fed against the knife until the whole of its edge is skived.

(*b*) The cutting device in the "Fortuna" machine is a steel cylinder sharpened from the inside, which rotates at right angles to the direction of the feeding; the latter device is a crown faced corrugated wheel, and by changing the shape of the pressure foot the shape of the finished edge can be given varying degrees of hollowness. It is an excellent machine either for leather, fibre board or buckram.

(*c*) This group includes machines like the "Perfect" and the "Young"; the stiffener would be passed between two cylinders, one of these is shaped as though a perfectly fitted stiffener had been depressed into it and then removed, thus leaving a hollow, while the second cylinder is so shaped that a raised part depresses the material into this mould, then while it is held in this position the stiffener is brought into contact with a flat knife which removes all that portion which cannot be sunk into the mould; the stiffener is therefore skived both at the top and at the bottom, and with the wider scarf at the ends, by just passing it through the machine once; an experienced operator can obtain excellent results with the machine, and on the same principle toe-puffs and shanks may also be prepared. It is necessary to have separate moulds for each size stiffener.

316. When leather toe-puffs are used they should be carefully sorted, and if they are not uniform in substance, or if they are stouter than necessary, they should be put through the splitting machine; unless this is done the toes of the shoes when made will not be similar in size. The bottom edge of the toe-puff is skived to reduce the difficulty of lasting it in; the top edge should be skived with a suitable scarf to prevent its edge spoiling the appearance of the finished shoe and to reduce the probability of the upper breaking away at the termination of an inadequately prepared edge.

317. In the preparation of insoles two things are necessary, *viz.*,

eathering and moulding. "Feathering" refers to the bevelling of the dge of the insole to produce a "feather edge"; the motives for doing his in either McKay, riveted, or screwed work would be :—

(*a*) It assists the blending of the upper and the bottom, by reducing the suddenness of the change from the lightness of the former to the heaviness of the latter.

(*b*) The effect of the foregoing is to lessen the probability of the upper cutting off by the edge of the insole, for if a piece of anything is fastened—to increase its length—to something which is much more rigid and then an attempt is made to bend them, they will not bend in a curve, but practically all the bending will take place where the weaker is fastened to the stronger, and if they are flexed many times the lighter material through exhaustion will break off at the junction of the two, consequent upon all the hinge-action or bending being at one place, and for the same cause an upper breaks off by the edge of an unfeathered insole, unless the boot is too stout to be flexed by the foot.

(*c*) Feathering the insole makes it possible for the upper to form a nice curve at D (fig. 114), where it is held between the insole and the outsoles, since that part of the insole (B) which is outside of the sole attachment device — AC — acts like a tapered spring.

(*d*) When the substances which form the bottom of the boot are very much compressed by the method of attachment, as, for example, in either a screwed or machine-riveted boot, then if the insole has not been feathered there will be a depression around the insole at A formed by the line of screws or rivets; this will result in the edge B of the insole curling up, thus causing discomfort to the foot, but if the insole is properly feathered there will be no ridge to hurt the foot.

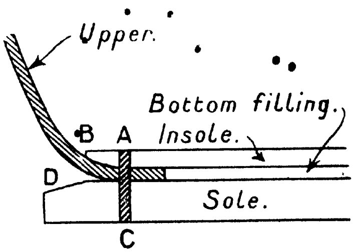


FIG. 114.

(*e*) When an insole is feathered it enables the finisher to use a very much wider fudge wheel than would otherwise be possible, since the flat surface at D (where the fudge wheel would be impressed) extends underneath the edge of the insole B.

In the operation of feathering the insole the principles which determine the amount of the reduction both in width and depth must not be overlooked. Under no circumstances must the bevel reach the line of the method of attachment AC (fig. 114), since this would reduce its efficiency; hence it should not be wider than $\frac{1}{8}$ inch.

The amount of reduction possible at B will depend upon the nature of the leather in the upper and the quality of the material in the insole, but the edge must not be weakened so much that it is unable [illegible] withstand the strain of the upper.

In either McKay sewn, riveted, or screwed work usually only the sides of the insole are feathered, since if the toe were feathered it would not be so well qualified to withstand the heel-to-toe tension, besides which it usually has considerable compression when the pleats at the toe are hammered down. It is also very important that the seat should not be feathered, the reasons being that :—

(*a*) It might then be too weak to keep the stiffener in position.

(*b*) It is not desired that the upper should form a curve at the seat, on the contrary it should fit close to the sole.

(*c*) A fudge wheel is not used at the heel.

(*d*) The presence of the stiffener precludes any probability of the upper breaking off through fatigue.

318. Insoles can be satisfactorily feathered by machine at much less cost than by hand, whence it is now included in Bottom-stock preparation. There are many machines in use for feathering, each having its admirers; they may be summarized as follows:—

(*a*) A felt roll is covered with an abrasive, the insole being supported on a small movable table which is underneath the roll; the surface of the table being at an adjustable angle to the roll enables the operator to bevel the edge of the insole as he may desire; it is claimed that the machine is useful when insoles are reinforced with fibre board, but the machine is not so frequently seen in factories as some others.

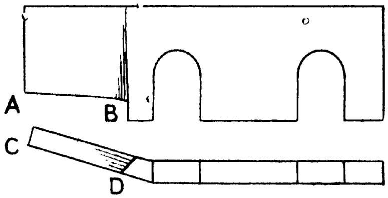


FIG. 115.

(*b*) There is a small machine similar in principle to an outsole channelling machine, which uses a knife the size and shape of which is indicated by fig. 115. AB is the cutting edge, and CD shows the angle at which it is inclined; the machine may be worked either by hand or by power and the work is very satisfactory.

(*c*) A machine by the Standard Engineering Company has four knives set in a head which revolves on a horizontal shaft, each blade being bent as in fig. 115; a shield is placed vertically on either side of these blades so that when the shaft is made to revolve the operator only has to place the insole between the two shields and draw it towards himself. The machine is very rapid and the circle formed by the revolving knives is so small that the most curved of waists can be correctly feathered even by a comparatively speaking unskilled workman.

(*d*) The "Fortuna" machine (§ 315) may also be successfully employed.

319. The moulding of the insole is an operation that merits more attention than it receives, since it would often considerably lessen the laster's difficulties, it being conceded that if in addition to straining the upper to the last, the workman must also press down a harsh and dry insole into the hollow waist of the last, then this must increase his labour—especially when work is machine lasted, since the rest against which the insole is pressed cannot possibly keep down its edge. But even with hand-lasted work where the difficulty of causing the insole to conform to the shape of the last is so much less, yet it is a great advantage to have the insoles moulded because the boot will be more like the shape of the last when the latter is withdrawn. It may be urged that the operation of lasting moulds the insole to the shape of the last; this may be true and doubtless would be sufficient if the laster could use the insoles while they were mellow, but this would necessitate using an insole superior in quality to that which is now used (and they would then have to remain on the lasts until dry); otherwise with the strain of the upper they would pull out of shape. It must also be remembered that the leather used in bottoming boots cannot readily be made to retain any moulding, unless it is in a mellow condition, therefore the attempt to mould it while it is dry is almost futile.

If a wide range of lasts is used then two sets of moulds will be necessary for women's work, one set for lasts with low heels and a suitable angle of the joint, the other set for lasts designed to carry a higher heel, in which case the joint line will not be at so great an angle; to bend the leather is not sufficient, it should be *shaped* to the bottom of that particular last. The moulding of insoles is a process of economy, since it enables better boots to be produced, the enhanced value being much greater than the cost of the operation.

320. If for the present we leave the channelling of soles (§ 328) and the fancy stitching of middle-soles, we may consider the bevelling of the latter preparatory to attaching them to the soles, and before the soles are moulded. Reference has been made to the varying length of the forepart according to the height of heel (§ 92) and also to the alteration in the angle of the joint (§ 25); middle-sole knives are generally made to serve for more than one set of lasts, and therefore the authority having them attached to the soles should see that in these details they are correct for that particular last, since it is very difficult for the finisher to plough out of the waist the excessive length of middle-sole, or afterwards to finish this part of the edge satisfactorily. The angle of the bevel of the middle-sole will vary according to the shape of the waist of the last, whether hollow or flat, and if for a high or low heel; as a general rule the higher the heel the more steep the bevel, and therefore the lower the heel and stouter the middle-sole the longer the bevel. When only light middle-soles are used, they may (after mellowing) be attached to the soles, in which case they will only be kept in position in the finished shoe by the attachment which holds the soles. When used in this way the middle-soles may be attached with tingles, provided that they are sufficiently short that they do not pass through

and spoil the face of the sole; otherwise they may be kept in position with an adhesive, either rubber cement or paste being employed; should the latter be used it would be necessary to subject the soles to pressure to ensure adhesion, the moisture from the paste would then keep the soles in temper.

321. It is quite possible that the edges of the soles and middle-soles may not now be level, as there may have been a difference in their shape, or in their size; possibly the employé did not correctly attach them, or they may have slipped when they were being put into the press; but whatever the cause the effect is to increase the difficulty of some subsequent operations, such as the opening of the channels (since the protruding middle-sole would prevent the sole fitting against the guard), or the attaching of the sole, it being now more difficult for the operator to judge when the sole is quite level; the edge trimmer's task, moreover, is not an easy one when uneven amounts have to be taken off around the edge; he must first trim the middle-sole to the outsole and afterwards trim the full edge to the feather. Therefore, since the labour of removing this excess cannot be avoided, and that delaying to do it makes other operations more difficult and less satisfactory without effecting any economy in expense, many manufacturers have the middle-soles trimmed up to the soles immediately; usually, however, this plan is only adopted where the preparation, lasting and finishing are under one authority who is equally interested in each of the processes.

322. Before the soles are moulded the shanks should be fitted, even if they are purchased already prepared, since the sole can then be blocked down on each of its sides, and this will result in less labour being required to shape the bottoms at the levelling machine. Leather shanks should always be mellowed, since leather cannot be successfully moulded while it is dry. Wood shanks are tougher after soaking in water; to avoid splitting they should not be nailed too near the ends, and the nails used should be as fine in gauge as possible.

323. When the soles have been moulded according to the principles in § 319, then the channels should be opened without delay. The operation is comparatively simple, the edge of the sole being placed against a guide, while on a level with the surface of the sole and in a plane parallel to it, a wheel revolves, its bottom edge being thin so that it slips under the edge of the channel, and as this is lifted it comes into contact with two projections—one on either side of the wheel, and these by a series of taps lay back the lip of the channel. Two important principles should be remembered:—

(*a*) Channels cannot be successfully opened unless the leather is mellow.

(*b*) The channel should be *laid back*, not forced back. The condensing of leather while it is mellow is very easy, and it afterwards occupies less space in the direction of the condensing, therefore, if the lip of the channel is forced back, the condensing will result in decreasing the surface measurement of the sole just behind the channel, and this will be evident at the channel closing, since it will be impossible to make the lip again cover the channel.

324. Stiffeners are often moulded before the laster receives them; it is very important that a suitable mould should be used, since if it does not coincide with the last no skill on the laster's part can secure a satisfactory result; if the curve is insufficient the top of the stiffener will project at the back, while if the curve is too pronounced then the top of the back by coming too soon into contact with the back of the last will render it impossible to make the bottom (H, fig. 90) fit against the last. To keep the number of moulds as few as possible it is advisable to use templates as in fig. 116, and all new lasts should be designed to fit these. In the fitting-up department there should be a full list of the lasts being used and against each last should be entered which of the moulds are to be used. The principle of the moulding machine is as follows: a part representing the heel of the last is held bottom upward, this we will call A; on each side of this and extending to the centre of the back is a block, these two we will describe as B and C; they both move backward and outward, leaving a space between them and block A; when a stiffener is inserted in this opening and the machine set in motion then the blocks B and C close up to A and mould this portion of the stiffener. A plate now comes forward from the back of the heel, and turns over the portion which stands above the block A. This latter operation, however, may be varied considerably, and may even be omitted when the stiffeners are to be used on welted work, the seats being wiped in on the bed-lasting machine. If, however, the seats are to be lasted on the "Consol," the back part of the stiffener may be moulded and the ends left free, otherwise the welt sewer may have some difficulty; even for McKay work many prefer this style of moulding on account of the variation in the shape of the waists of lasts, but when fibre board is used it is advisable to mould the whole of the bottom line. Material which cannot easily be moulded by hand can often be nicely moulded by machine.

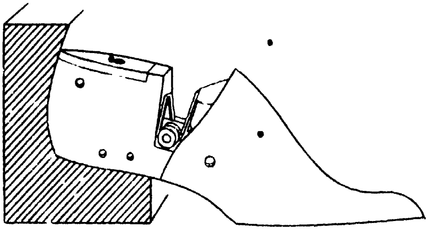


FIG. 116.

325. Opinion is not quite unanimous as to which side of the stiffener—the grain or the flesh—should come next to the foot, but if the skived side is not selected then it must be carefully skived, otherwise with a light leather such as glacé kid, the appearance of the shoe may

be impaired. When the material, is not of a mellow tannage, the difficulty of lasting in the seat may be considerably increased by putting the grain side next to the foot, since it does not gather itself in as readily as the flesh side; the principal argument against it, however, is the tendency of the grain side of leather to contract when it dries after being wetted; with very many persons the dampness from their feet is quite sufficient to cause considerable contraction of the grain, and this results in the stiffener curling inward, and unless the edges have been perfectly skived they become so keen that the lining at the heel is soon cut through, causing considerable discomfort, and that this is not unusual may be verified by examining boots that have been worn. It may be said that if this curling had taken place towards the outer side it would have been still more serious, but fortunately the grain side would not then be so easily affected by any dampness from the foot seeing it would first have to penetrate the thickness of the stiffener. When it is intended to put the grain side next to the foot, then it should be buffed to reduce its tendency to curl.

326. For the purpose of reinforcing stiffeners a covering of heavily sized canvas may be used, or otherwise, a small piece of leather may be attached with an adhesive; in the latter case it should be attached previous to skiving so that appearance and comfort are not avoidably marred. A choice must now be made between two evils: (*a*) putting the grain side next to the foot so that the small piece used for strengthening is then between the principal part of the stiffener and the upper leather; or (*b*) placing the smooth grain side next to the upper, in which case there would only be the thin linen lining to hinder the paste absorbing the natural dampness from the foot, which would quickly result in the loss of its power, hence when the foot was being forced into the boot this small piece would be pushed down, thus reducing the efficiency of the stiffener and causing discomfort, whereas if the stiffener be placed as in *a*, the adhesive is less likely to be injured by dampness and the small piece used for supporting it would not be so quickly displaced.

327. When stiffeners are cut from split or from material which is not sufficiently solid, they are sometimes dipped into strong size, and when it has sufficiently set they are moulded; by this means they are considerably improved. Good stiffeners either of leather or fibre-board are, after moulding, by some foremen dipped into size and then put on racks to drain and dry; when required for use these would be dipped into water and let stand for the coating of size to absorb the moisture, it would not now be necessary to use any other adhesive on them, since they are perfectly coated on both sides, yet with so little moisture that the lining, even though of delicate shade, would not be discoloured.

328. *Channelling the outsole.*—The reasons for channelling outsoles are that:—

(*a*) It enables the stitch to be sunk below the surface; this protects it and delays its being worn away, in which case its strength would be gone.

(*b*) Sometimes the only reason for using a channel is to improve the appearance, for example in a screwed boot; in a McKay sewn boot the hiding of the stitch certainly improves the boot's appearance.

The using of a channel would sometimes be difficult on account of the unsuitability of the leather, in which case just a groove may be used.

Channels differ as regards the distance of A (fig. 117) from the edge; the distance between B and D; the distance between B and C; and the shape between A and B. Channels for hand-work (unless they are cut by machine) would be quite straight between A and B, and B would not be much farther from D than A is, because the stitching will be placed on the welt between the feather and the edge of the sole, and when the channels are cut by machine and the stitching is also to be done by machine the shape between A and B is nearly, if not quite, straight.

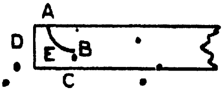


FIG. 117.

Channels for McKay work differ in several details. The distance between A and D may remain the same, but the distance of B from D must be determined by the relation of the insole to the outsole, and the nature of the leather in the sole, but it must be possible for the sewer to place the sewing $\frac{1}{8}$ inch inside the edge of the insole, and since it is more difficult to open the channel in hard rigid leather it would be necessary to cut it a little larger. The shape of the channel between E and B is very important, since if it is nearly parallel to the surface of the sole the foot of the sewing-machine will have a much better bearing and the sewer will not find it necessary to tilt the shoe so much; therefore when sewn the bottoms will not be so round. When the work is to be screwed the channel between E and B must be nearly flat to enable the cutters to cut off the screw close to the leather, and the substance between B and C must be sufficient for the screw to have a good hold. With McKay sewn goods the sole should be channelled as deeply as possible, considering the nature of the leather and the character of the boot; if the fibre is brittle more substance must be left and stout hard soles would break away if no more substance was left than is found to be sufficient for light goods and pure bark-tanned leather. With much of the leather that is used to-day it is found to be an advantage to use a groover at the back of the channel knife; this will cut away a little of the sole substance—about the size of the sewing thread—and cause the channel to be as at F (fig. 118). If the sewer places the thread in this groove it facilitates channel closing and enables the bottom to be made flat without bruising the sole on the stitches. When shoes are made with only a single sole there is a tendency for the bottom to become very round owing to there being less resistance than usual to the sole

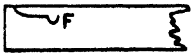


FIG. 118.

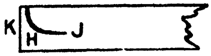


FIG. 119.

being forced up in the centre when the shoe is tilted; to lessen the necessity of tilting, a channel is used in which B is a little farther in than usual from the edge. The style of finishing sometimes calls for a variation in the channel; it is generally cut a uniform distance from the edge all the way around, but when the shoe is finished with a half-round strip, the channel in the waist would be placed farther from the edge, to avoid exposing the stitches in cutting down the waist.

In America it is usual to cut a channel with a very much thinner lip (as in fig. 118) than is common in England; it is easy to open and easy to close, but it is necessary to employ cement to keep it down, and even then it is not unusual for it quickly to wear off, leaving the stitch exposed; as already pointed out B should always be as near as possible to C (fig. 117).

Sometimes the edge of the sole is split; the reason for so doing is that it obviates the necessity of using a top-iron—there being no channel to hide—and in this detail to imitate the sewround.

When two rows of thread are placed in the same channel—as for example in imitation Veldtschoens—then its shape should be as fig. 119; at H it would be deep enough to bury the stitch, and J must be far enough from K that the sewing is the correct distance from the edge of the insole.

CHAPTER XXIX.

LASTING.

329. ASSUMING that the upper, the last, and the necessary bottom stock are provided, the next processes to be considered are those incidental to moulding the upper to the last. Brads or *bills* should be used to attach the insole to the last; the toe-puff and stiffener should now be placed in position in the upper, an adhesive being used preferably on both sides of the stiffener, since it prevents the upper working down over the heel in wear and saves the lining being pushed down by the foot when putting on the boot; the strain of the latter often causes the lining to be soon worn away. It is not usual to put an adhesive next to the upper when it is either glacé kid or patent, since it would spoil the appearance. Experiments have been made with many adhesives, but it is doubtful if rye-flour paste has been surpassed, since it allows the materials to glide over each other, whereas dextrine is far too sticky to permit this; the paste, however, should not be so thin that the linings are in consequence soiled.

The upper must be strained over the last in such a way that it fits closely into the hollows and retains the curves of the last when the latter is withdrawn; this is more difficult than it would at first appear to be, the material of which the upper is made being both flexible and elastic, so that although on account of its flexibility it can easily be made to conform to the last, yet on account of its elasticity when the last is withdrawn the contraction which takes place may result in the shape being lost; therefore if the upper is to retain the shape of the last the moulding must take place according to scientific principles which are referred to as "drafting". *Drafting therefore denotes the process of moulding the upper to the last in such a way that it will retain the shape of the last even when the latter is removed.*

In the hoisting system of drafting and with normal lasts and uppers the processes may be as follows :—

Place the upper on the last and turn it bottom upwards; the upper should now be lowered at the heel, so that instead of lapping over on the insole it is about ½ an inch below the edge of the last; after examining the heel seam and being satisfied that it is in its correct position, take the toe of the upper in the pincers (see Appendix I.) and strain its edge over the insole and then tack it down; this must be the first strain for the following reasons:—

(*a*) It centralizes the upper on the last and at once enables the operator to see if it is correctly machined; no tacks should be placed elsewhere until the upper has been centralized with this one.

(*b*) When this strain is taken the upper will generally be stretched, and since the last is not uniform in size it will in some places come forward to a smaller part of the last; therefore if other transverse strains had been taken they would now require adjusting.

(*c*) This longitudinal tension is the only one which could mould the upper to the back of the last, but it would be difficult—even if possible—to set up effective tension after cross-strains had been taken.

(*d*) It is important that shoes should have a tension around the tops, but this can only be secured by a longitudinal strain which can be most effectively set up before taking cross-strains.

(*e*) There is no other strain which could make so much of the upper fit against the sides of the last, but to be effective it must be the first strain taken.

(*f*) It is the only place at which a strain could be taken, unless it were a temporary strain to be afterwards adjusted. Seeing the importance of this first strain it is desirable that there should be some guide as to the tension which ought to be set up; it may be stated as follows: *set up as much tension as possible, provided always that you can with your fingers bring the upper down to the most hollow part of the last between the instep and the toe.* Several factors either singly or in combination might affect the tension which will then be set up, yet they present no difficulty if this rule is observed.

(1) The last may be hollowed at the front, or be flat (§ 330); but by this rule the tension set up will never be so great that the upper cannot be brought to the last.

(2) The upper may be almost straight in its front line or be hollowed by the pattern cutter, yet sufficient length line will be allowed to permit the upper being brought to the last.

(3) The material in the upper may be harsh and without stretch, or it may, like wax calf, have considerable stretch; this would be ascertained as the upper was pressed to the last by the hand.

(4) The substance of the upper must be considered, light materials stretch more than heavy ones.

(5) The nature of the lining must not be overlooked; stout fabrics do not yield much, but leather linings may stretch considerably. Yet each of these contingencies is automatically provided for by the rule suggested.

It is of the utmost importance that the tension be put on gradually, not with a jerk (especially with patent leather); it is often through a want of care in this detail that some lasters crack all the patent caps they handle. While the tension is being set up, see that the differing sides of the last do not affect the position of the upper. Fig. 120 illustrates how the upper at D stands away from the last after taking the first strain; the triangle, whose apex A is at the top of the puff, CB being the base, represents the portion of the upper generally influenced by this strain.

330. The second and third tacks are usually taken at the sides of the cap. The line ADE in fig. 120 is shorter than the line AHJ, and therefore whenever D is brought to H, E will come forward an amount nearly equal to the difference in the length of the two lines; the last gradually decreases in its girth from E until it reaches H, and thus any strains taken between H and J, previous to D being brought to H, must be readjusted when the upper comes forward through being brought down at H.

The amount which the upper at D stands away from the last at H will depend upon:—

(*a*) The cut of the upper; with short vamps the pattern cutter can shape the pattern to the last, but an increase in the length of the vamp will also increase this difficulty.

(*b*) When lasts are straight in the front the uppers can be shaped to fit them, but this cannot be done so well in very hollow lasts, hence the upper at D may then stand away considerably.

(*c*) The distance between D and H is increased as the upper is hoisted.

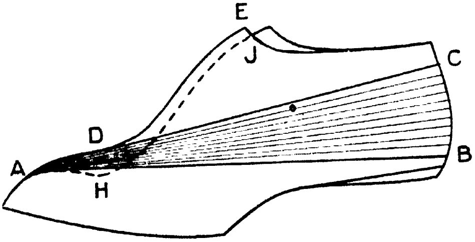


FIG. 120.

The effect of bringing the upper from D to H is to increase the heel-to-toe tension, because the line ADC must now be brought to AHC, but this should not be difficult if the correct tension was set up by the first strain. The difference between the distances ADC and AHC will indicate the amount of increase in the tension.

The upper was stretched in its length when the first strain was taken, although only that triangular area was affected which is represented by the toe of the last as apex and the back of the last as base; but since uniform tension must be set up, if there is to be uniform contraction it follows that the remainder of the surface of the upper must also be stretched in its length, hence the direction of the strain for the second and third tacks must be that which is indicated by the arrows in fig. 121, and the area affected would be represented by an isosceles triangle having M for its apex and KN for its base. The second tack is taken at the inside of the toe, because it is usually more difficult to bring the upper down to the last on this side; there is also less probability of making the front seam crooked, since on the outer side, especially on some men's lasts, the thinning away of the last at this place makes it difficult to bring the upper down to the last without pulling the front out of position, in which case readjustment would be necessary (see § 334).

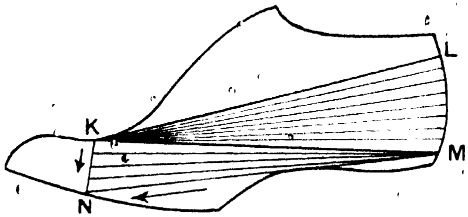


FIG. 121.

331. Usually the fourth tack is put in at the back of the heel, but as the upper was placed below the edge of the last when the first strain was taken it will now be necessary to 'hoist" the upper into its correct position, which is *resting on the comb of the last.* If when the tack is put in at the back, the upper stands away from the last as at P (fig. 122), then when the waist strains are taken, P will be brought down to R and the line of tension AB will be distorted to ASB. The effect of this will not be visible until the last is withdrawn, but the upper will then

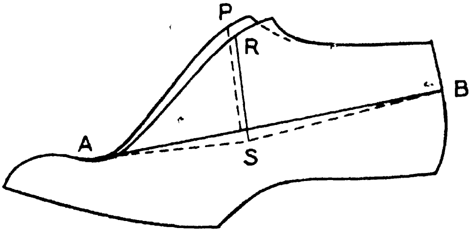


FIG. 122.

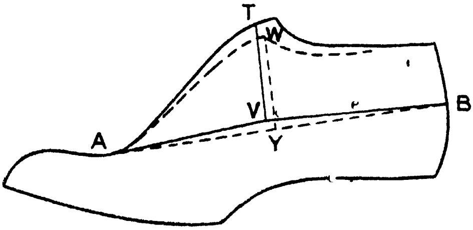


FIG. 123.

have a dragged appearance in the waist. If the upper is cut too small in the heel, so that when it has reached the comb of the last there is not sufficient lasting allowance and the upper has to be pulled up further, then the effect will be as in fig. 123, AVB indicating the distorted heel-to-toe tension; when the last is withdrawn the distorted line straightens itself and the line TV sinks to WY, so that the boot is then not the shape of the last.

If a last is examined end-ways, it will be seen that it is very much broader near the seat than at the top, and if a tape measure were passed from A around B and back to A (fig. 120), and then from A around C and back to A, the second measure would be smaller than the first; hence it follows that when the upper is pulled up at the heel, the heel-to-toe tension must be increased, since the upper is now drawn over a part of the last which is larger; this is often referred to as "an application of the mechanical principle of the wedge".

332. The fifth and sixth strains are taken at the heel—one at either side; the lining must be attended to lest it should be unsatisfactory in the finished shoe, and *the stiffener* (if of leather and unmoulded) *should be strained towards the toe, and then pulled up at the corner* until its top edge fits against the sides of the last; the stiffener should not be designed so that excessive pulling up is necessary, since increasing the fullness to be worked in around the heel, with leather that is not easy of compression, would increase the difficulty of obtaining a smooth seat.

The upper may now be laid over the edge of the last in a straight line and should never be so strained that it results in the heel-to-toe tension being distorted. With shoes it is advisable to last the inside quarter first, since on account of the shape of the last it is the least liable to be overstrained; when the outside has been lasted both sides should be equal in height.

333. (*a*) The seventh tack should be placed in the hollow of the inside waist just behind the joint—W (fig. 124); the effect of this is to equalize the tension which is set up along the bottom between tacks 2 and 5; this uniformity of tension (which is so essential to ensure uniformity of contraction) cannot be obtained if the strain is taken over the joint at P (fig. 124), because in taking the strain at R a greater tension would be set up along the bottom between P and S than between P and T; hence the contraction being more uniform when the strain is taken at W the shape of the boot will be more like that of the last.

(*b*) If this strain is taken at right angles to the feather it assists in removing from the upper any fullness which there may be between the joint and instep.

(*c*) It facilitates the lasting in of the waist, since there is a greater length line of upper to yield than there would be if a strain were first taken at P; this is especially important when the pattern-cutter has shortened the bottom line of the pattern.

(*d*) The form of the last at the inside joint is more likely to show in the finished shoe if the strain is taken at W, since instead of the leather being stretched over the joint it is moulded around it.

If a straight edge is placed transversely against the last so that it touches the outside joint and instep, it may usually be noticed that between these two places there is a hollow, and obviously if the upper is strained over the joint the tendency will be for this also to form a straight line between the joint and instep, to do which it must come away from the last, but if the strain is taken at V (which is behind the outside joint and almost on a straight line drawn from the toe to the heel) then the upper will be moulded into the hollow and the finished shoe be more like the last. The reason why the seventh strain is taken at the inside joint instead of at the outside is that the last, being hollowed so much at the outside, there is a great tendency for the upper to slip to that side and thus cause the front seam to be crooked, whereas at the inside the last is so convex that there is not this danger.

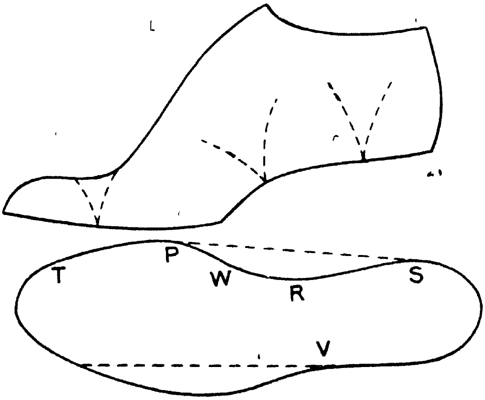


FIG. 124.

Curved lines have been used in fig. 124 to indicate the effect of the strains, because the area affected by each pull is in the form of a triangle whose apex is at the jaws of the pincers; it may also be observed that the sides of the triangles are often deflected by the contour of the last.

334. Although much importance may be attached to the position and order of the draft tacks which have just been described, yet these alone are not sufficient to ensure a perfect result, since this may be entirely lost through the strength of the tensions set up not being in the correct ratio. To study this it is an advantage to fix a last on a pedestal in such a way that a cord may be passed around the back of the last and over the toe; it is advisable to fix in the toe of the last a small staple to keep the cord in position, yet allowing it to work freely; the cord should be attached to a spring balance at the end of which there must be a device for holding it, the object being to permit the

increase or decrease in the tension of the cord, the spring balance registering the tension set up. Another cord should now be laid across the toes where the second and third tacks are usually placed, a spring balance being similarly attached on either side with facilities for its easy adjustment; experiment will show that for the cord across the toes to be able to bring the heel-to-toe cord to the last the tensions of the cross strain must be equal to the heel-to-toe strain. In the manufacture of boots however these tensions are not always evenly balanced, in many cases the heel-to-toe tension is so great that it is impossible to bring the upper to the last with the cross-tensions; should the tension be excessive, then when the last is removed this heel-to-toe tension will assert itself and cause the upper to fall in at the sides.

335. In connection with the lasting of boots one difficulty is seldom absent, *viz.*, that occasioned by the elasticity of the leather in the upper; most of the upper leathers have some stretch, there being generally a tendency to contract after the tension has been released, and this may seriously affect the appearance of a boot, since the contraction will be proportionate to the tension set up, and where the latter has not been uniform the former cannot be; yet the defect does not appear while the upper is on the last, but when the latter is removed the defect is evident.

It is therefore a part of the art of lasting to mould the upper to the last with strains that are uniform to secure uniform contraction, and the reason why workmen who have been accustomed to one class of work cannot easily pass to a lighter class is because they have not developed a sufficiently delicate judgment as regards the relative strain set up with each pull.

Uniform tension, however, is not the only thing necessary to secure uniform contraction, for if with the same tension there is unequal elasticity then unequal contraction will follow, and this involves a further tax on the judgment of the operator; sometimes, however, this can be easily guarded against, since experience teaches that where two or more thicknesses are machined together the elasticity will become practically negligible; hence there will be no contraction, and it may be observed that boots with several seams, such as circular vamps, caps, or goloshes, generally retain the shape of the last better than those without seams, provided always that the laster has strained the upper at the seam and never by its side, since the latter would result in unequal stretch (of this we often have an illustration, *e.g.*, when vamps are strained by the side of caps).

Uppers are not often made of only one thickness; usually there is a lining, sometimes of leather but generally of fabric, and it is very important that the contraction of each of the thicknesses should be uniform, otherwise if the outer material contracted more than the lining then the latter would show an undesirable fullness; the ideal process is to take each thickness separately and, after straining it, to release it, then when each thickness has been strained and released they should be all pulled together; the material which has the minimum of stretch now indicates the maximum of stretch obtained, and hence when this tension is released they will each relatively contract.

336. When toes are lasted by hand it is usually by one of the following methods:—

(*a*) It may be pleated when the material is of such a pliable nature that it is not difficult to dispose of the fullness; the various thicknesses (however many) should always be strained at one and the same time, and if the line CD, fig. 125, is only two-thirds of the length of the line AB then it will be evident that the width of the pleat at CJ must be narrower than at FH by a corresponding amount; if a centre is fixed as at K, then the line of each of the pleats should radiate from that point.

(*b*) With stout and harsh material it is necessary to cut it at each of the pleats, the direction of the incision should be as explained for the pleats, but *the cut should be made so that when the material at J is lapped over C it will glide up an incline;* the tingles should be placed far enough in from the edge that they do not cause broken needles (Blake machine), and each should be as close as possible to the previous tack, but ought not to go through the previous pleat. Where one pleat laps over another such as J over C, the overlapping piece may be trimmed off.

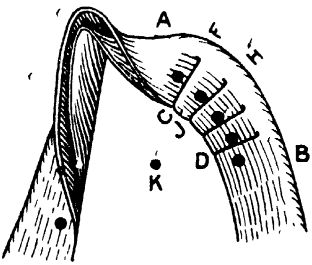


FIG. 125.

337. There are circumstances when the foregoing method of drafting can with advantage be varied, for example:—

(*a*) *The toe may be lasted in after taking the first three draft tacks* should it be so short that there is barely sufficient material; or if the material is so tender that there is a probability of breaking it, in which case the toe need not be strained so much since extra-tension would be put on when the upper is pulled up at the seat. On lasts that have very high toes, or with uppers which have whole goloshes that are cut to lock in, there would be a lot of fullness at the toe; it is then an advantage to sink the upper considerably at the heel, and after two or three pleats had been made on either side of the toe the upper could be raised a little at the seat and the second and third draft tacks adjusted, after which the remainder of the toe is lasted in.

(*b*) *After the first three draft tacks, take side pulls at A* (fig. 123) when the boot has either a deep vamp or deep golosh, or any other style of upper which has prevented the pattern cutter making the upper hollow like the last. The same method is adopted when the front of the upper is unduly shortened by springing the toe of the pattern; or if the heel-to-toe tension exceeds the normal through the last being very hollow in the front, or the puff being very high. When the upper has been hoisted and the remainder of the draft tacks put in, it will be necessary to adjust these joint tacks.

(*c*) *Tacks two and three may be taken at the most hollow part between the toe and instep*, if through the hollowness of the last or the straightness of the upper it is difficult to bring the upper down to the last where tacks two and three would generally be put; these tacks must afterwards be adjusted.

(*d*) When uppers are cut from material which has considerable stretch it is sometimes difficult to set up effective heel-to-toe tension without causing the front of the straight cap to come forward, thus making its sides appear to be running back; in this case, after lasting the whole of the shoe except the toe, the front tack should be released and the second and third tacks adjusted, after which gently pull the cap over the toe and last it in.

338. Before considering other methods of lasting it would be advisable to set down the *principles of lasting*, *i.e.*, *the rules by which we seek to obtain the desired results*; they are as follows:—

(*a*) The draft strains should mould the upper to the depressions in the last.

(*b*) They should be in the order in which this can be most effectively done.

(*c*) Set up each tension at the most effective time.

(*d*) And when it would be the least adversely affected by after strains.

(*e*) The intensity of each strain should be correct as regards its ratio and its relation to the rest.

(*f*) Never take a strain by the side of a seam.

339. Uppers are said to be lasted by the hoisting method when they are placed lower than the seat of the last for the first strain, so that it is necessary to "hoist" or raise them to enable the seats to be lasted. When the upper is put level with the seat of the last for the first strain it is called "seats level"; and when the upper is first tacked over at the seat it is called "seats up". The other draft tacks for the "seats up" method of lasting would be as follows: second at the toe, third and fourth at either side of the toe, and the remainder in the same order as by the hoisting method.

There are several advantages claimed for the "seats up" method of lasting:—

(1) The heel seam being fixed in position there is greater probability that the front will also be straight.

(2) It is possible to use a machine moulded counter.

(3) It permits the bottom line of the pattern to be shortened, therefore there is less material to last in at the seat.

There are, however, many disadvantages.

(1) The great mechanical advantage of the wedge is lost.

(2) All the heel-to-toe tension must be put on by straining the upper over the toe of the last.

(3) It is therefore difficult to put on effective tension, especially

(*a*) If the uppers are of tender material—such as patent toe-caps;

(*b*) If the vamps are very deep, since the upper cannot be hollowed to the last;

(*c*) If the uppers are of material with considerable stretch—as waxed calf;

(*d*) If lasts are very hollow in the front, the design of the upper being such that it cannot be hollowed.

(4) It requires a longer upper, since less heel-to-toe tension must be used.

(5) It is essential that the uppers fit the last.

Under the following circumstances the haisting method is the better :—

(*a*) When lasts are very hollow;

(*b*) When uppers are short;

(*c*) When the patterns cannot be hollowed by the pattern-cutter;

(*d*) When the material is harsh with little stretch;

(*e*) When the material is tender;

(*f*) When uppers vary in length.

340. Lasting is now done with the assistance of machinery since it effects an economy in time; in addition to this the team system which is then used tends by the subdivision of the operations to do away with those distinctive features which are so noticeable when an operative does a large amount of work on any shoe; hence we conclude that subdivision of labour tends to produce uniformity. There is also another advantage since it results in a concentration of energy on each of the little details which then becomes the sole work of some member of the team; thus at the same time that an economy is effected in cost, there may also be a distinct gain in the quality of the work produced. When work is done on the team system uniformity of output is one of the results since A must keep B supplied; and C must either do his part to that which has passed A and B or give place to a quicker man. The possible output of the team is always limited by the speed of the slowest man.

341. Lasting machinery may be considered as forming several groups as follows:—

(*a*) *Machines which only drive the tingles, the straining being done by hand;* the well-known "Boston" lasting machine is an example.

The boot is supported on a long "jack" having a universal joint, and when the operator has strained the upper with ordinary "laster's pincers," it is held in position with the fingers while the jack is swung under the tack-driving device. The drafting and moulding of the upper is in this case essentially a hand operation, hence the quality of the output does not depend upon the machine but upon the operator.

(*b*) *Machines which put in the longitudinal tension and the transverse tension across the toes, afterwards securing it by driving in tingles;* the "Rex" and "Gimson" pulling-over machines belong to this group.

342. The principal devices on the "Rex" appear to be essential on any drafting machine and are as follows:—

(1) The rest against which the bottom of the last is placed.

(2) The automatic heel-rest which adjusts itself to the length of the last.

(3) The five pairs of pincers, two at either side and one in the centre.

(4) Devices to cause them to grip the upper.

(5) The up-draw device with compressed air chambers to prevent the tension being put on suddenly; and the springs to regulate the tension according to the requirements of the upper.

(6) The device to cause the jaws of the pincers to lay the upper over the edge of the last, with the means of adjustment for lasts differing in width.

(7) Device for straightening the cap, if necessary.

(8) Device for straightening the front of the upper, if necessary.

(9) Device for releasing the grip of the front pincer to enable the work to be brought down on the last by the transverse tension device.

(10) Device for delivering and driving in the tingles.

The machine has one great advantage over hand work, *viz.* that the tensions are put on simultaneously, and no tack need be driven until the upper is quite straight and down on the last: the work can also be handled quicker, besides which it would be impossible at similar cost to get equal work done by hand (see §§ 334 and 344).

343. *(c) Includes machines of the "Consol" type.* This machine has been varied and improved so many times that no description could possibly enumerate all its forms; there are, however, some devices which will probably remain, even though the means of bringing about each result may be considerably improved; for example, there must be the following:—

(1) Pincers to grip the upper.

(2) Device to make them grip the work and control the strength of the grip.

(3) Device to give the necessary motion, such as remaining open until they have reached their lowest position (which should be when they are nearest the edge of the insole), then after gripping the upper they must rise and in so doing strain the upper to the last, but the amount of rise must put on uniform tension notwithstanding the variable amount of material to be pulled up; the pincers must now draw the upper over the edge of the insole and finally release the upper.

(4) Device to regulate the up-draw tension to make it suitable for various leathers or materials.

(5) Device to regulate the strength of the over-draw according to the immediate need.

(6) Device to find and deliver the tingles at the right time and in the correct place.

(7) Device to control the driving in of the tingles.

The following adjustments may be considered as additional:—

(8) Device for giving to the pincers a twist motion to assist the disposing of any fullness.

(9) Device for cutting the material at the toe when it is too stout to be pleated.

(10) Device for using tacks differing in length.

There are also many minor devices some of which are referred to in § 344.

The "Consol" type of machine is often (not necessarily) used in conjunction with the "Rex" pulling-over machine, the work being drafted with the upper in either of the three positions (§ 339), but unless the "seats up," method has been used it will now be necessary to hoist the seat, after which the corners of the stiffener must be pulled up; as to whether the work will also be drafted at the joints will depend upon the class of work being made, the ability of the operator, the fit of the upper on the last, and the quantity required from the machine.

Although it is not possible for the best operator on the machine under all circumstances to do work equal to the best hand-laster, yet it must be admitted that if the conditions are correct, satisfactory results can be obtained by competent operators, since there is not a single principle of lasting (§ 338) which cannot be observed. It should not, however, be overlooked that on good-class work with hand labour it is usual to take the stretch out of the material, and then let it contract before taking the moulding strain, and that this not only causes the stretch to be more evenly distributed, but also reduces the amount which the upper would probably stretch in wear, thereby considerably improving its suitability, since in wear it would not so quickly lose its original shape; this is very important especially with curried leathers, but separate stretching of the material is entirely ignored in this type of lasting machine.

344. (*d*) *A group of machines specially adapted for welted work.*

In these machines two special features are required, since the upper instead of being lapped over the edge of the insole (as in McKay work) is now tucked into the groove formed by the outside channel (§ 361); in addition to this the tingles which are used must not be driven in more than part way—except at the seat—since they will presently have to be withdrawn. The longitudinal and transverse strains may be set up by machines in class *b* (§ 342) provided they are adjusted so that the tingles are left standing above the material. When the seats have been hoisted and the corners of the stiffeners been drafted, then the sides of the boots may be lasted by machines of the "Consol" type, provided the correct tingles are used and that they are only driven in part way; sometimes, however, bed-lasting machines are used, and "Stirkler's Triumph" may be taken to illustrate the type. The machine has three pairs of pincers arranged on either side of the boot, the three pincers on either side being mounted in such a way that uniform tension is exerted by them; both sides are strained at the same time, the intensity of the tension being at the discretion of the operator, but the strains, being taken straight across, cannot mould the upper as successfully as when they are taken at right angles to the feather, especially just behind the joints; hence as there is not very much gained in speed we are not surprised to find many machines on the market which omit the side pincers, such as "Gimson's Bed-Lasting Machine," the "Standard Rotary," and the "Universal". The essential feature of these machines consists in the "wipers" at the toe and the seat; the stiffeners for the latter should only be half-moulded.

The boot is placed on a "jack" which is adjustable in height, as is also the toe-rest. The seat-wiping device is on a carriage so that its distance from the toe can be adjusted to suit any size; it can also be adapted to any angle of waist. The principle of the device is to use two plates parallel with the bottom of the last, having a hinge-motion from the centre of the back; these are moved forward by a lever so that they bend the stiffener down flat on the insole, while at the same time the two ends of the plates (where draft tacks 5 and 6 would be) approach nearer to each other so that at these places also the stiffener is gathered in and flattened down; the plates can be brought down tightly on the insole and satisfactory results obtained; the plates, however, do not cover the whole of that which is turned over, but leave a sufficient amount exposed that tingles can be driven in with the assistance of the hand-tacker; this being a small tool which feeds the tingles one at a time through a tube, the power to drive them in being supplied by hand. At the toe there is another pair of plates, and in a manner similar to that which is used at the seat, the upper is worked into the shoulder, there being a number of small adjustments which differ with the various machines. There are several devices for holding the upper in position when it is lasted; two tingles may be left one at either side of the cap (called "anchor tacks") and a piece of wire or waxed thread may be fixed to one of the tingles, then drawn tightly around the toe and fixed at the other side. In a similar manner on the "Consol" type of lasting machine which is used for welted work, a wire held by the machine may be strained into the groove, while the pincers strain up the material, the wire being fastened as already described. On most of the bed-lasting machines, however, a cotton bracing-tape is used in the following manner: having cut off a piece of suitable length and tied the ends, the tape is then passed over the anchor tacks at the joints and made to lie in the groove all around the forepart, after which it is passed over a device just behind the joint so that with the assistance of a lever on the machine it can be strained tightly, after which it is fixed by tingles being driven through it in the position of the anchor tacks, the previous tacks being removed. After the upper has been well-blocked into the shoulder in the waist all tacks—except those which secure the bracing-tape—would be withdrawn. At the present time staples are sometimes used for holding the upper in position, the "Upper-Stapling Machine" being employed. Sometimes machines of simpler construction are used, such as the "Perfecta"; this only consists of a jack with a device by which a steel wire can be strained from the back of the shoe into the shoulder and thus wiping in the toe, which is afterwards secured by one of the methods already described. The machine is not sufficiently powerful for heavy work, but light work may be satisfactorily handled.

Messrs. Johnson & ses Fils, of Paris, supply a machine which is similar in design.

345. (*e*) *Sometimes boots are lasted by the "Tackless" system*; this necessitates the fastening of a cord to the edge of the upper with a zig-zag machine, so that the cord can slip through the loops of the stitches; a suitable insole is used on the bottom of the last and the special machine provided engages the cord on either side of the waist and strains it, this causes the edge of the upper to be gathered in, the tension being increased until the upper conforms to the last; the edge of the upper is now glued to the insole, and the sole having been attached, the McKay sewing may be proceeded with.

346. Whether work is lasted by hand or machine it is very important that it be hammered down as soon as the lasting is finished; the seat especially should be made flat to enable the sole to lie close against the upper, otherwise the finisher's work will be unnecessarily difficult; the sides of the seat should be beaten up close to the last and the outline made true, with both sides alike and a square edge; it is not often that the workman responsible for this operation realizes its importance, not knowing that it is against this that the heel-trimming guard works; bad seats make good heel trimming impossible, and the heel scourer must do much unnecessary work in consequence. At the toe there is often an unlevel place caused by the gathering in of the fullness, this should be made flat with the hammer if it can be done without difficulty, but generally it is an advantage first to remove as much surplus material as possible with the knife, and then to finish it with the hammer. It is not unusual for the work to be done with the assistance of special machinery such as the "Stanlock" knocking-up machine, or the "Rex" pounding-up machine, both of which have devices for removing any excess of material at the toe, and in both cases the pounding-up is done with a series of rings set in rows; in the "Rex" there are eighteen rows and fourteen rings in a row, the object being to avoid the friction which otherwise would be set up: either machine has smooth wheels with curved surfaces, so that the toes and seats may be ironed to assist the shaping. The "Wentworth" heel-seat beater is somewhat different in pattern, the beating-up device being on the same principle as the "Expedite" heel-burnishing machine, which has a number of plates each on separate springs; otherwise like the others it is supplied with a device for removing the excess of upper material and also an ironing device.

347. If nails were used to keep the insole in position on the last they must now be removed; there is a disposition on the part of some operators on the pulling-over machine to dispense with the operation of fixing the insole in position, but there is a difference of opinion as to the advisability of this, since if it is not fixed the operator cannot work quite as quickly because he must always examine the work to see if the insole is satisfactory, and if it is not he must endeavour to make it so with the device which is provided, and even then it is not a rare occurrence that the insoles are not true with the bottom of the last; but this

is not surprising since some experience is requisite even for correctly tacking the insoles on the last. Nails with large flat heads should be used, as they can then be driven flat with the insole and are easy to remove with an old knife.

348. It is always advisable to use bottom-filling, *i.e.* a piece of material to fill up the hollow in the forepart of the insole between the two edges of the upper; when this is omitted it is often difficult to obtain a flat bottom at the levelling machine, although this is so essential to good finishing; but even though on account of the stoutness of the bottoms this unevenness may not be so pronounced, yet in wear the insole would soon become unlevel because of this hollowness. Sometimes the bottom-filling is cut from felt, or the roundings of upper leather, which, however, must be free from grease, and sufficiently large to cover the whole of the forepart (see § 364).

349. Middle-soles (when not attached to the sole, § 320) must now be secured in position; the number of nails which it will be necessary to use will depend upon the size of the boot—whether men's or children's, the substance and nature of the material in the middle-sole, and the kind of attachment; but three things are important, since it should be put on quite true as regards the amount of margin beyond the feather at the toe and on either side, otherwise it will be exceedingly difficult to put the sole on true; the bottom should also be made quite flat, since if this is not done now it will be more difficult afterwards, even if it is possible; the middle-sole must also be cut across at a suitable angle, correct length, and proper bevel as explained in § 320. The method of fitting the shank will depend upon the kind of shank being used, but it must be fitted up against the bevel of the middle-sole and extend back under the heel far enough for strength, otherwise the best of shanks will be as useless as a spring the end of which is not fixed.

CHAPTER XXX.

METHODS OF ATTACHMENT.

350. For the purpose of contrasting the merits of the various attachments we may tabulate the features desirable in an ideal boot.

(1) Durability of attachment probably takes precedence, since without it the boot would not be serviceable; under fair conditions it should certainly last as long as the material in the upper.

(2) The attachment should not be injurious either to the foot or to the material in the upper.

(3) Generally the attachment should make the shoe reasonably waterproof.

(4) It should be sufficiently flexible to be comfortable and to permit free exercise of the various muscles.

(5) Cost of production cannot often be ignored.

(6) Sometimes the ease or difficulty with which it can be repaired is very important, at other times insignificant.

(7) Lightness is sometimes a very desirable feature.

(8) Some attachments may be considered "ideal" for one set of conditions, but be most undesirable if the conditions were changed.

(9) Gracefulness in the product is an essential feature of an ideal method.

351. The various attachments may be classed under three headings: (*a*) Metal, (*b*) Wood, (*c*) Thread; they may also be divided into direct or indirect attachments, and horizontal or vertical seams.

All metal attachments are "direct," the sole being attached to the upper, but if something were attached to the upper, such as a welt, and the sole was then attached to the welt, it would be described as an indirect method of attachment. Metal attachments are always vertical seams, the device used being in every instance vertical to the surface of the sole. When rivets are used the strength of the attachment will depend upon a machine-made head on the outside, and on the inner side if the rivet is driven by hand, a burr must be formed to prevent the conical point working backwards. Machine-riveted boots are stronger than hand-riveted, since the rivets are always driven in at the correct angle, and in addition to this the point has two flat sides like a spear; consequently when this point comes into contact with the cup of the horn it curls up, so that a hook is formed which makes withdrawing it almost impossible. If the head of the rivet is subjected to wear then the strength of the attachment is soon impaired, but if the boots are to have hob-nails then the heads of the rivets would not be so liable to be worn off, and with any but the most suitable leather for insoles they would be more satisfactory than a screwed boot. Riveted boots are reasonably waterproof but very rigid and the tingles used in lasting often injure both the foot and the material in the boot; it is the cheapest style of manufacture, however, and being easy to repair it is a popular attachment for low-priced goods where flexibility is of minor importance.

352. Screwed boots are superior to riveted because the strength depends upon the thread of the screw; in principle these are the same as ordinary screws except that they have neither point nor head, being cut off close to the leather as soon as the revolving head of the machine has screwed them in; consequently they still grip even when the leather is worn down very thin, but it is important that the insoles should be suitable. The attachment is a rigid one but considered to be very waterproof; it is a little more expensive than the riveted to make but is easy to repair; it is not suitable for light goods.

353. Wire sewing is not a very popular method because unless the insoles are good they become unlevel, besides which the method is rigid and the steel wire used, together with the tingles, are both injurious to the leather. The method of sewing is as follows: a wire of sufficient length is driven through the sole, and then the cup on the horn turns the point of the wire back into the insole, while on the outside the point is turned down into the sole and curled in until it is out of sight.

There are several other devices but of much less importance.

354. Boots are sometimes made with wood pegs instead of metal rivets. Tingles are not used when lasting the hand-made pegged boot, and what nails are used are only driven in part way, being afterwards withdrawn when the upper is secured in position by what is known as "bracing"; a single thread is used, and only just a sufficient number of stitches to hold the upper in position are put while the rest of the bottom is attached. It is necessary that good stout insoles be used, and the wood pegs must be well dried; with a pegging-awl a hole must be made the full length of the peg since they cannot cut their own holes; the whole of the point of the peg must project through the insole because it has no power to hold, for it is only the friction of the peg on the hole that keeps the boot together, hence the holes must not be made any larger than is really necessary. If a false insole is used on the last it facilitates the slipping of the last when the boot is made, the false insole would then be removed and the projecting pegs cut off with a special tool called a "peg knife," after which the insole would be made smooth with the peg rasp. Pegging may be done on the "Davey" pegging machine; the wood is supplied to the machine in strips, and from these the machine cuts the pegs. At one time the reputation of the pegged boot was second only to the hand-sewn, but it is far less popular to-day. The attachment was used for boots that were to be worn under damp conditions, such as sea boots; they are considered to be less rigid than screwed boots.

355. There are many varieties of thread attachments. The "McKay" or "Blake" is a direct attachment with vertical seam. The work is lasted as already described, and when the sole has been temporarily fixed the shoe is placed on the horn of the machine and sewn. The needle, or hook as it should be called, combines the functions of awl and needle; when it has pierced the sole so that the barb of the hook is quite through the insole, then the thread (by one of several methods this must have been waxed, § 371) which passes up through the horn and through the side of a tiny, toothed wheel (called a whorl) is rapidly made to encircle the needle, thus placing the thread in the hook; the needle now ascending pulls up the thread, then, having reached its highest motion, descends, but the thread instead of descending slips out of the barb of the needle, and a tiny rod with its end flattened out like a clasp quickly covers the barb to prevent the return of the thread; in the meanwhile the shoe has been moved along the necessary amount for a stitch, and the needle now descends through the centre of the loop which it had previously pulled up, and when at its lowest motion the thread again encircles the needle, and as the latter ascends a loop is again pulled up, but since the tension on the spool thread is greater than the friction on the thread from the previous loop, the slack thread is pulled up tightly, thus forming a stitch as in fig. 126. The machines used for this style of bottoming vary considerably, although their essential devices have changed but little; the principal are:—

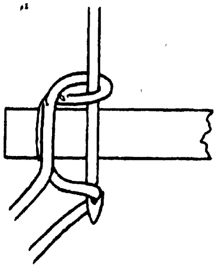


FIG. 126.

(*a*) Device for wrapping the thread in the barb of the needle.

(*b*) Device for cast off.

(*c*) Device for tension.

(*d*) Device for feeding the work along.

(*e*) Device for changing the length of the stitch.

Needles stamped the same size are not always the same in measurement, but they should always be used sufficiently small that the thread together with the wax fills up the hole. If properly made, the seam should be reasonably waterproof until the top of the thread wears off. It is flexible, easy to make and repair.

356. The "veldtschoen," or "stitchdown," has passed through so many stages that no description of it would correctly describe its production in all factories. The principal idea is that the edge of the upper (except just around the heel) shall be turned outward instead of being folded over the edge of an insole, and that this projecting flap shall be attached to the sole with a vertical thread seam. The heel part is always lasted as though it were for Blake sewn, and therefore this portion must have an insole. The appearance of the stitched portion is generally improved by putting around a narrow strip of leather called a "welt," since it

imitates the appearance of one; the shoe is not lasted in the same sense in which a McKay boot is lasted, for the upper is merely strained forward on the last and then three or four nails put in, usually at the vamp seam, the remainder of the lasting being done by the pincers on the stitching machine. This method of manufacture is very flexible, and the cost of production is low, but the shoes are not as smart as the products of other methods of manufacture and they are not easy to repair. The method is restricted in the home trade to house shoes and children's goods, but it is also used for outdoor wear in foreign countries having a dry climate. To enable a more shapely shoe to be made, a light insole is sometimes used, and the lining properly lasted using an adhesive to fix it in position; when this is done a toe-puff can be used and better results be secured. Should an insole not be used it will be necessary after the last is removed to use some suitable material to bring the foot up level with the welt which has been stitched around, otherwise it might be a source of discomfort. The imitation veldtschoen is quite common; the method of production is first to stitch on the flesh side of the sole the narrow strip of welting, the shoe would then be both lasted and sewn exactly as for McKay sewn; it will be necessary to channel the soles correctly for the accommodation of the two rows of sewing.

357. The manufacture of the sewround differs from all other styles, since the shoe is made with the wrong side outwards and then turned. When made by hand, the stiffener having been fitted and the sole shaped, it is attached to the last with the flesh side upwards; the sole should exceed the last in width around the forepart by an amount equal to the total thickness of the upper, but around the heel it must equal the thickness of the upper and the stiffener. The sole having been shaped, is put on a flat board and feathered, including toe and the seat—to the extent of $\frac{3}{16}$ inch, according to the substance of the upper. It is next tacked down, and with a curved sewing awl holes are made where it is intended to take stitches; it is to be a horizontal and not a vertical seam, consequently the stitches will be nearly parallel to the face of the sole. The amount taken up with the awl must be sufficient to stand the strain of the stitch, and the point of the awl must come out at a distance from the edge equal to about two-thirds the width of the feather—unless a shoulder feather is used. The number of stitches to an inch will depend upon the class of work and size of thread to be used. There are generally about 4, but I have seen 16 stitches to an inch in some sewrounds which were lent to the Leicester Museum. The shoe will be lasted with the lining outside, care being taken to secure sufficient heel-to-toe tension; the tacks used should not penetrate the sole far enough that the finish is thereby spoilt, neither must they be driven in all the way, since as the shoe is sewn they will be withdrawn; it is usual not to sew the lining around the heel. When the sewing is finished the seam must be hammered down and then trimmed, cutting away the excess of material; when the last is withdrawn the waist of the shoe is first turned, then the heel, and lastly the forepart, after which it must be shaped by inserting

the last for the foot opposite to that on which it was made. The lining in the heel must be pasted and made to lie smoothly; it will also be necessary to put something inside to fill up the space between the two seams, for which felt should be used for preference, since this would not reduce the flexibility of the shoe; the shank should be fixed to this filling, or "false insole" as it is often called.

358. Many turnshoes are sewn all the way round, and are quite properly described as "sewrounds," but some turnshoes are not sewn round the seat, and in this case the heel part of an insole is fitted into the heel of the shoe and the seat lasted as for McKay work. There can be no doubt that seats made in this way are very much stronger, and therefore for the heavier classes of turnshoes they are preferable. When the seat is made in this way variously shaped heels may be attached, but sometimes only a single lift is put under the seat of the sole—the front of the lift in this case must be bevelled—and the heel of the sole can then be riveted round. If rivets are objected to, the seat must be sewn.

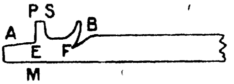


FIG. 127.

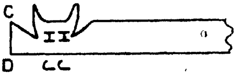


FIG. 128.

359. Many turnshoes are sewn by machine; this involves considerable change in the preparation of the soles, since two channels will be necessary, one on the feather, which will form a shoulder against which the stitch can be tightly pulled without fear of breaking the seam as A, fig. 127, and a channel further in from the edge for the channel guide to travel in, and which will enable the stitch to be strained up on this side, as B, fig. 127. These channels, however, may be varied considerably; in fig. 127 the edge is split and then opened, and as a result the edge does not represent the full substance of the sole; in fig. 128 this disadvantage is overcome by cutting the channel at an angle, so that CD is the full substance of the sole; in fig. 129 a piece is cut away leaving a shoulder, a machine is then used to cramp or bend down this part of the sole in the direction of the dotted line. The distance between E and F, fig. 127, should never exceed $\frac{3}{16}$ inch and with favourable conditions $\frac{1}{8}$ inch may be used. It is the distance between H and J, fig. 128, that is important, since the nearer H approaches J the less can the sole be worn before it is cut through. I have seen shoes where the centres of the soles have dropped out before the leather was worn half through its thickness, because of the depth of this channel. In the process of lasting the work must be bedded into the shoulder A, fig. 127, and since that which is now next to the last will, when the shoe is turned, become the outside of the shoe, it will follow that folds or pleats must be carefully avoided—in McKay work, however, the folding of the material which comes next to the last might not have any serious conse-

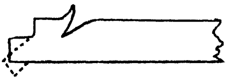


FIG. 129.

quences; it is also important that the material which is now next to the last be not strained so tightly that when the shoe is turned the contraction will be such that it causes the lining to be in folds. The shoe may be sewn on the ordinary welt sewing machine if the welt guide is changed, and in its place a rest used, which holds the upper against the shoulder on either side of the needle for the formation of the stitch (see § 361, *d*). In the selection of the thread judgment must be used, since the probability of the seam giving way during the sewing will to some extent depend upon the size of the thread, and it would not be wise to use a large thread if the material in the upper would only give a little wear.

360. When the shoe is sewn, the lip of the channel B, fig. 127, must be laid down and any nails must be withdrawn, after which the upper is trimmed close to the stitches, but not close enough that the strength of the seam will be impaired; the work may be done with an ordinary knife or a machine built for the purpose may be used. The last having been slipped, the shoes may be turned with the assistance of specially constructed machines, one for the heel, and another for the forepart; in the latter case the shoe is slipped on one horn and the upper is then rolled back over another one in line with it; the process is similar to that adopted in removing a tightly fitting glove from the hand. Second lasting—that is inserting a last that will strain the shoe into the desired shape—is rather tedious work, and if the back of the shoe has been excessively curved, or if the top of the shoe stood above the last when the heel-to-toe tension was put on, or if through any cause the tension was excessive, it will then be difficult to insert the last and in consequence the back seam may be strained if not broken; this danger is considerably reduced when the "Turnshoe Reforming Machine" is employed, because a forme diminished in size is used, and is therefore easily inserted, after which this is forcibly expanded with the assistance of compressed air chambers; the machine is rapid, and when seen it is soon appreciated. Manufacturers whose trade is not large enough to justify installing the machine just described, may be interested in the adaptable jack supplied by the "Tom Cann Co." of Leicester, which, although slower, is certainly a great improvement over the old method; its principle is similar to that in the former machine, the expansion being effected with a screw. When the bottom-filling and shank have been fixed in, the bottom of the shoe can be moulded into shape and rolled—usually by machine, it being important that without burning the sole all wrinkles be removed; the seat must be made a good shape and also the toe. With a view to ensuring a close fit round the top of the shoe notwithstanding the strain which it has in manufacture, lasts are sometimes altered in shape for the first lasting. The illustration (fig. 130) is from lasts supplied by Messrs. Creece & Son of Leicester; it will be observed that, in the last on which the shoe is made, the difference between the length of the bottom line and that which would be round the top of the shoe, is much greater than between similar lines in the last used for second lasting; and in addition the difficulty of tightly lasting the waist has been reduced. In the first last the fullness is below the line of heel-to-toe tension.

361. The ideal method of attachment is the hand-sewn welted boot. In making boots on this principle the leather to be used in the insole is mellowed and moulded to the bottom of the last; often the pincers are freely used, but this cannot be recommended since in wear there would be an undesirable amount of contraction; when leather is stretched in this manner it should afterwards be allowed to dry thoroughly without restricting its tendency to shrink. When the insole has been shaped to the last it must be feathered; the width of the feather will depend upon whether a specially close welt is desired, and on the nature or class of boot to be made; it should not be overlooked that a wide feather on a very stout boot would be undesirable, since it would then require a very special insole to keep the upper in shape, but more important still is the fact than an abrupt feather is much stronger to sew against, the orifice of the hole on this side being stronger. Sometimes either a small channel or a shoulder is cut on the feather to ensure a true line where the awl emerges from the leather, and sometimes a channel is also used where the awl is inserted in the leather; the advisability of this must be determined by the nature and substance of the insole, also the size of the awl and the thread; with brittle leather (which ought not to be used) it is unavoidable, and the same applies to insoles which are light in substance compared with the size of thread which it is necessary to use; the insole must be feathered around the toe, but the feathering of the seat will depend upon how the seat of the sole is to be attached. When the insole has been holed and the toe-puff and stiffener fitted and inserted, the upper will be ready for lasting. If the seat is to be sewn in, the bottom of the stiffener must not be reduced much in substance, since it will not be lapped over on the insole. The theory of lasting will be exactly the same as for McKay sewn except that the tacks used will only be driven in far enough to hold the upper until the welt is sewn on; the

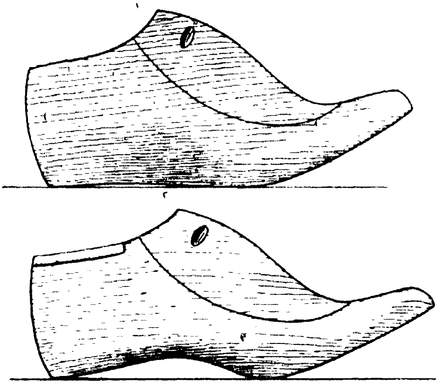


FIG. 730.

pleats at the toe are therefore formed in a different way, but an endeavour is made to get the toe as free from pleats as is possible by the wipers in bed-machine lasting (§ 344), the process being first to divide the fullness at each side of the toe, then to subdivide these new pleats, the operation being repeated until all fullness is disposed of. When the upper is lasted the welt must be prepared; this is usually a strip of leather about ½ inch wide cut from a shoulder which has been curried for that purpose; fig. 131 shows a section of the welt and the little bevel which is taken off to assist its fitting against the feather; the direction of the stitch can also be understood from the illustration; the method of making the stitch is shown in fig. 132, the two ends of the thread are used, both being put through the same hole, one from the right-hand side, and the other from the left, the process being repeated for each stitch. When the welt has been sewn on the excess of material at A, fig. 131, will be cut away to make the bottom as flat as possible, but even then it will stand above the centre of the insole B; therefore this must be filled up (§ 362), and when the shank is fitted in, it will be ready for the sole—assuming for the sake of brevity that the seat is to be pegged. The sole must now be shaped, leaving a sufficient width between C, fig. 133, and the upper, that a row of stitching may be

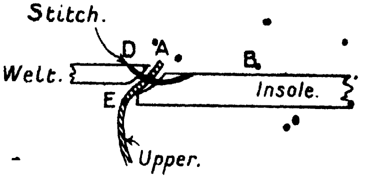


FIG. 131.

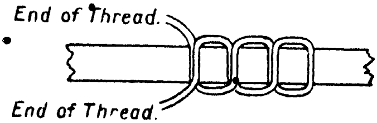


FIG. 132.

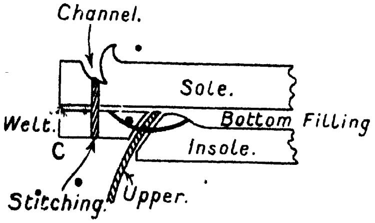


FIG. 133.

placed without fear of damaging the welt-stitches. The sole is thus attached to the welt with a vertical thread seam, but as it is not directly attached to the upper it is described as an "indirect" method of attachment. It is the most flexible method of making boots that are too stout to be made sewrounds; both of the seams would be waterproof if properly made, but hand-welted boots are expensive to make and to repair.

362. Hand-sewn boots are often imitated by machinery; they may be described as "Goodyear-welted," after the inventor of the machinery, or they may be described as "Machine-welted". The principal differences between the hand-made boot and the machine-welted are the preparation of the insole and the making of the stitches. The ideal leather for the insole is the centre portion of a firm oak-bark tanned belly, since the fibre would possess the maximum of nature and be neither too long nor too short. The channels used would be similar to those in fig. 127; the outer channel at E is made about $\frac{3}{16}$ inch from the edge, and the thickness between E and M about $\frac{2}{3}$ its substance; between E and F there should not be less than $\frac{1}{8}$ inch nor more than $\frac{3}{16}$ inch. For the purpose of finishing the waist without the stitches showing it is not unusual to increase the distance of E from the edge; when the boots have toe-caps the extra thickness of the upper would cause the sole-shape to be different in design from that of the last, and to minimize this difference the point E would be a little farther from the edge round the toe than at the sides; the machine which is used for cutting these channels has facilities for the ready adjustment of these differences, so that it would then only be necessary to press the lever with the foot for either the waist, forepart, or toe. Many boots are made with what is known as "Gem" insoles, which consist of leather insoles that are too light in substance to be used in the ordinary way, therefore only the outer channel is cut, adhesive canvas being then bedded down over the upturned portion, PS, fig. 127; the merits of this insole will depend upon the nature of the leather, the thickness of PS, and the character of the boot; often the decrease in the utility of the boot is much greater than the amount saved by using a substitute for solid leather. The method of lasting has already been described in § 344. Several machines are used for sewing on the welt—both lock-stitch and chain-stitch—and some of these have often been improved, but the principal devices of chain-stitch machines are as follows:—

(*a*) *Heating device.* This must provide not only for the waxing of the thread, but for keeping warm each part of the machine with which the waxed thread comes into contact, such as thread rolls, looper, and needle, otherwise they would quickly become coated with wax and this would make it impossible to work the machine; gas is sometimes used for heating, but many modern machines are fitted with steam-heating devices, and if a steam engine is already in use then the employing of steam would be economical and reduce the risk of the thread being impaired by overheating.

(*b*) *A channel guide* is important, because if the needle be correctly set and its point the right shape, then the channel guide will indicate where the point of the needle will come through; it also serves to steady the work when the needle strikes it.

(*c*) *A welt guide* is necessary to feed the welt and hold it in position so that the needle strikes through the groove which is cut at D, fig. 131; the stitch should lie in this groove, but the latter also assists in the turning out of the welt. There must also be an arrangement whereby the pressure of the welt guide against the shoe is relieved when the latter is carried along to form another stitch.

(*d*) *A stitch-forming device.* The seam being horizontal, the stitch cannot be made in precisely the same manner as the McKay, although the finished stitch is identical; when the needle (which enters on the welt side) has emerged from the insole, the looper with a circular motion lays the thread in the barb of the needle; the other details are similar to those in the McKay except that there is no "cast off".

(*e*) *A tension device* is necessary so that notwithstanding the varying substance at different parts of the boot, the tension which is put on the stitch when it is pulled up, may be uniform. *In both hand and machine work the strength of the seam does not so much depend upon the number of stitches and size of the thread, as upon there being an absence of hinge action between the different parts which are sewn together* such as welt, upper, and insole.

(*f*) *The "feed"* which controls the length of stitch should be variable, since it is necessary to increase the length with an increase in the size of thread used, otherwise there may not be enough material between the stitches to stand the increased strain.

When the welt has been sewn on, the tacks used to keep the insole in position must be removed, likewise the anchor tacks used for bracing; this may be accomplished by hand or with the aid of one of the power machines used for the purpose. The seam at A, fig. 131, must now be trimmed so that the sole can fit flat upon it as in fig. 133. In factories only making a small number of welted shoes this would be a hand operation, but if possible the "Keighley" in-seam trimmer should be installed; the cutting device consists of a fine toothed band-saw strained taut over two wheels; the machine is both rapid and true.

363. It will now be necessary to "beat out" the welt; this is done with a small power hammer, the shoe being held so that the welt is supported on the side of a small horizontal disc—sometimes only a bracket—which is bevelled to permit its thin edge fitting in at E, fig. 131. The disc revolves as the boot is moved to bring a different part of the welt under the hammer, and thus friction on the side of the upper is avoided. This "beating out" results in a slight compression of the welt which of course must be in temper, as would also have been necessary when the welt was being sewn on; the outline of the welt will have to be longer than the line where the sewing is, and to assist it to stretch it is usual to make a few small cuts around the toe. The seam at A, fig. 131, may now be painted over with a composition which should help to make it

waterproof. A seam-sealing machine is supplied by Gimson & Co., Leicester.

364. The filling of the bottom is an important operation; it may precede the fixing of the shank, or it may not, since this must be determined by the material used in filling the bottom: the objects of the latter operation are:—

(*a*) The making level of the forepart of the outer sole.

(*b*) To make it possible to secure uniformity of surface in bottom scouring, and afterwards in sole finishing.

(*c*) On account of the hollowness of the bottom the foot would otherwise soon cause the inside to be unlevel and uncomfortable.

(*d*) It assists in making the boots more damp-resisting.

(*e*) If suitably filled it should prevent the unpleasant sound caused by the surfaces of dry leather rubbing against each other. Several materials have been used, the selection being made in some instances to secure efficiency, but more often it is economy that dictates.

A waterproofed felt of good quality may claim precedence, since it never creaks, and is also cheap and easy to use; sheet cork is sometimes used; that, however, which is most popular is ground cork mixed with a compound which is both adhesive and plastic when heated, but solid and waterproof when cold; "Besto" and "Arabol" are two well-known compositions, but a special outfit is desirable with either material for softening it, and filling the bottom.

365. When the soles—which are generally cut with a master-knife—have been bevelled in the waist (from the flesh side) they must be mellowed; if they were not reduced in this way they would appear stouter than in the forepart owing to the sole being raised over the shank through the centre of the waist. The machine used is known as a "Shanking-out" machine. It is now usual to apply a coating of rubber cement to the edge of the sole that will rest upon the welt, and to that part of the welt upon which the sole rests, and when the solvent has evaporated the sole would be placed in position, and then the boot—the last being in it—is placed under pressure until the sole is firmly held in position; there are several appropriate machines on the market.

366. Many manufacturers now let the shoes go to the "rounding" machine, but for good work it is a great advantage to beat out the welts again; it does not take long, but it sinks the welt close to the sole so that the stitches do not at places sink into the welt.

The rounding machine is one of the most useful machines in the trade, since besides shaping the sole and welt it also cuts the channel, the expense of purchasing knives for each last is therefore saved. The principal devices are:—

(*a*) The guides which, working against the feather, determine the width of the welt. The narrowest part of the welt will be the waist, since it is usual, in ladies' shoes especially, to finish this part without showing the stitches, but it must not be so close that the awl cuts into the welt-stitches. With a pedal an additional guide may be brought into action, so that around the forepart the welt can be left wider.

When it is desired, a Scotch edge attachment may be used, which enables the operator to trim the welt wide at the outside joint, gradually decreasing the width as it reaches the toe; it is brought about by a cam which must be adjusted according to the size of the boot.

(*b*) The cutting device is like a small chisel—about ¼ inch wide—which makes a series of slightly overlapping cuts as the feeding arrangements bring the next part of the welt against the knife.

(*c*) The channel knife is adjustable as regards the distance of the cut from the edge, and also its depth; the knives are produced in a variety of shapes.

367. When the channel has been opened (§ 323) the work will be ready for the stitching machine. So many machines are on the market, with either of which satisfactory work can be done, and these vary so much in their construction, that no useful purpose would be served by describing either one in detail. The principal feature in a well-stitched edge is the appearance of the stitches; these should be uniform in length, and in the amount which they are sunk in the welt; hence the mechanisms which affect the length of stitch and the tension are of primary importance, speed being secondary. The stitch used is a "lock-stitch" (fig. 79), the thread which shows on the welt is usually passed through a solution of gum, there being an advantage in so doing since in subsequent operations it is less likely to be soiled. The shuttle thread is usually waxed (§ 370).

When the cost of production prevents boots being made "hand-sewn," they may be made by machine; if, however, the work is very heavy and is likely to be often worn under damp conditions the welts may be sewn on by hand, the remaining operations being performed by machine; the principal advantage is that the hand workman can use hemp, but the machine would use flax, hence it is not unusual for strong boots to be made in this way. Although it is not admitted that a lock-stitch can be equal to the hand-made stitch, since the hole for the former must be made large enough for the "lock" to pass through, whereas the hole for the latter would be less than the size of the two threads, yet it is generally strong enough; and should it give way it can easily be repaired, whereas if the welt-seam gave way it would be difficult, and *it should always be a principle in the construction of a boot to make sufficiently strong any seams that are subject to much strain in wear, the repairing of which would be difficult.*

In many welted boots, whether made by hand or machine, a middle-sole is used in the forepart between the welt and the sole; this has several advantages since:—

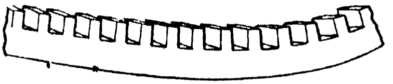
(*a*) It would be more difficult for dampness to penetrate to the feet.

(*b*) When the outer sole became thin the foot would not so keenly feel the unevenness of the footway.

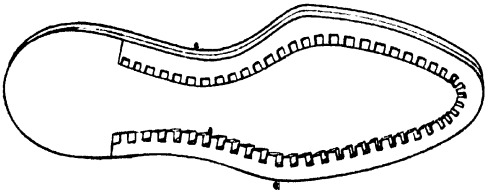
(*c*) The boot would keep its shape better; in welted work there is always a tendency for the welt to curl upwards in wear, but this is prevented even with a very thin middle-sole, provided that the leather is firm; consequently the boot does not so quickly lose its smartness.

368. Every good thing is imitated, consequently there are many imitations of welted boots; the "fair-stitched" is a well-known example; this boot is lasted as for McKay and then a middle-sole may be attached by the McKay machine; after the sole had been temporarily fixed, it would be stitched to the edge of the middle-sole and the waist of the sole then sewn on the McKay. Sometimes instead of a middle-sole only a narrow strip is sewn on, the welt being held in position by a welt-guide attached to a Blake or McKay machine; the welt is shown in fig. 134; the forepart may be filled as in § 364.

Shooting boots or other heavy footwear may be lasted as for McKay, then when the bottom has been filled, a through middle-sole extending to the back of the heel may be attached either by machine-riveting, screwing, or McKay—preferably either the first or second; the sole would then be stitched to the edge of this middle-sole. It is described as an indirect method of attachment, of great durability, its efficiency being but little impaired even when it is necessary to re-sole the boots.



The Welt.



The Welt attached

FIG. 134.

369. For methods of direct attachment, soles may be temporarily held in position by any one of four different methods. High-class ladies' light shoes often have the soles cemented on; it is not denied that it is the most expensive method, but it is claimed that there is no risk of breaking the needles when sewing, or of nails working through and hurting the foot; neither is the appearance of the forepart impaired by the marks of sunken nails. Sometimes for light soles the staple-tacker is used; this machine cuts and points a staple, and then drives it in; the wire, however, must be sufficiently soft that the machine can work it, the result being that it may not be strong enough to penetrate hard soles. When staples are used they may be put in the channel, and the finish of the bottom will not then be impaired, but they often cause the thread to be cut through during sewing. When the wire-grip machine is used, the short lengths of corrugated wire, which are cut as

needed from the coil, are placed in positions similar to those used for the draft tacks in the forepart, only farther in from the edge than the channel; the driver is adjusted sufficiently low that the wire is sunk far enough below the surface to prevent the finish being affected except by the small puncture due to the wire. When the leather in the soles is hard, the "taper nail" machine is generally used; the nails in this case are cut from ribbons of steel, the width being identical with the length of the nails, which are shaped like an isosceles triangle, the base would be cut from one edge of the ribbon for the first nail and from the other edge for the next. The machine may be fitted with either a single or double head; in the latter case two widths of ribbon are used so that two lengths of nails can be used, the longer for the forepart and the shorter for the seat. Usually the operator does not use a guide for nailing the latter, which as a result is often unsatisfactorily done, but there are factories where an adjustable guide is fixed to the machine and the heel of the shoe rested against it; this ensures the nails being a uniform distance from the edge.

The seats of soles on extra heavy work are generally attached either with the riveting or screwing-machine.

370. *The Theory of Waxing.* A thread for hand work is made from many strands, and it is necessary to twist these so that the friction instead of being continuous on any one strand may be shifted to another, for example, the friction at A, fig. 135, is shifted to B and then to C. If a similar amount of each strand was subjected to uniform friction, the stretch of each strand would be similar, but when many strands are used then the friction would not be uniform, and those strands with most friction would be stretched most; this would make it impossible to use the thread, since the strands which stretched in length would double up, and cause an increase in girth at that place, the obstruction probably resulting in a breakage.

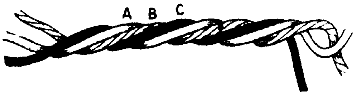


FIG. 135.

(*a*) If, however, a wax is used, it will cement together the different strands and prevent their unequal stretch. It may be remarked that cottons and threads used in upper-closing machines are often made of many strands and that they are not waxed, and yet do not loop up; this is true, but the strands are specially twisted to overcome this difficulty. (See § 172.)

(*b*) There is always a considerable amount of friction set up when the thread is passed through a small hole, but by using a suitable wax this friction is considerably lessened since by binding the fibres together the diameter of the thread is reduced. Wax also lessens the wear on the thread by acting as a lubricant.

(*c*) In a thread there is always a tendency to contraction on the release of tension; this would make it difficult to obtain a tight seam apart from some device to lessen or prevent this slipping back of the thread after pulling up the stitch, but this useful purpose is also served by suitable wax.

(*d*) Wax helps to make a seam waterproof by cementing the stitch to the leather and filling any space, if such there be; it also helps to preserve the thread from damp and from the fine sharp grit which incontrovertibly often does considerable damage to the thread.

Wax should possess stickiness and have as low a melting-point as is consistent with cleanliness in use. Brittle wax is dirty to use and soon leaves the thread; soft wax is best as a lubricant, hard waxes strain the leather and weaken the thread; hence threads allowed to hang for some time become weak because the volatile part of the greases having been oxidized, the wax becomes hard and brittle.

371. *Machine Waxes.* Threads with a soft finish do not strain the leather so much during sewing, and less tension will be necessary to make the thread lie flat on the material, but such threads have considerable elasticity, and to obtain a tight seam so much tension may have to be used that the thread is thereby weakened. When there is much elasticity there is also considerable contraction upon the release of the tension; therefore when the Blake needle after reaching its highest motion commences to descend, the contraction may cause the thread still to remain in the barb of the needle instead of allowing the shank of the needle and the cast off point to pass down through the loop, the result is a missed stitch, but wax, by preventing the contraction of the thread, overcomes the difficulty.

Soft threads are always loosely twisted and are often split on the barb of the needle, but this also is corrected with a suitable wax. (See also *b*, *c*, *d*, in § 370.)

Hard Waxes. This is a very serious defect, since when it is necessary to have the horn of the machine unusually hot so as to keep the wax sufficiently soft to prevent the motion of the whorl from being impeded, then the strength of the thread may be impaired; it should not be necessary to heat the wax above 75° C.

Soft Wax. Wax may have too low a melting-point, through there being too much grease or oil in its composition; when melted this would be very thin and likely both to splash and to make the work and hands of the operator dirty; such wax would not prevent the contraction of the thread, hence it may not leave the barb of the needle, or even if it does, yet the loop may fall to one side so that the cast off point cannot enter, thus causing a stitch to be missed.

372. Assuming that the shoes have been sewn or stitched the next operations will be channel-closing and bottom-levelling.

First of all the soles are wetted, for although the shoes may have been sewn before the soles had become quite dry, yet they are not in a fit condition for channel-closing; clean water should be used, otherwise the bottoms may be stained; the best and possibly the quickest method is to hold them against a revolving brush which is in contact with a supply of water, since it avoids the wetting of the uppers. The shoes should now be allowed to stand until the leather is mellow, this being essential for the proper closing of the channel. Shoes that have been made welted, will still be on the last, and these will be considered first. If there is much wax in the channel—there ought not to be—it will be an advantage to bone it down; the lip of the channel should then be worked back until the channel is completely covered, usually this is not difficult with the mellow leather generally used for welted work; it may be done with the keen edge of a bone, or a piece of hard wood; often the bottom of the shoe is held against the side of a revolving wheel that has raised ribs (the patterns vary) usually of brass, or gun-metal to avoid stains. The edge of the shoe may now be forced towards the centre of the bottom by holding it against a wheel the edge of which has raised ribs, otherwise a shoulder stick may be employed; this would be about 16 inches long, and about 1 inch in diameter made from either of the hard woods, such as box-wood; a shoulder would be cut into it—at about 5 inches from the end so that it could be fitted against the edge of the shoe and set it up square with the assistance of friction and pressure. The bottoms of welted shoes are levelled on machines having a spindle to hold the last in position; the bottom is then rolled with either one or two cylinders; when only one is used it is generally more or less concave so that the edge may receive the full force of the pressure; when two cylinders are used they are less concave and are placed end to end, they then adjust themselves to the curvature of the bottom.

373. The channel-closing and levelling of shoes other than welted or sewrounds is perhaps less satisfactory, since already the last has been removed from the shoe, and it is not often that the same last could easily be re-inserted; most of the machines in general use do not employ lasts at all similar to those on which boots are made, but "feet," and often the same foot is used for boots made on very different lasts; usually each foot has also to do duty for more than one length size; it need not therefore cause any great surprise when the finished shoe is found to have little, if any, resemblance to the last on which it was made; but it is difficult to understand why money should be so lavishly spent in purchasing the very latest creations in lasts, and then to allow the benefit to be lost through a want of care in the levelling department. The feet used should always agree with the last in—

(*a*) The pitch of the heel (§ 25).

(*b*) The position and angle of the joints.

(*c*) The spring of the toe (§ 28).

(*d*) The length size. When the feet used are much shorter than the shoe, and the bottom is levelled by rolling, then the toe of the shoe will be bent upwards through there having been no support at this part when it was rolled.

Shoes sewn on the McKay machine are often strained out of shape; this is not always the fault of the operator, but is more often the result of badly moulded bottom-stock; insoles that are not moulded to the shape of the last when mellow cannot be expected to retain the form of the last, and if while the soles are in a mellow condition they are not blocked to the shape of the bottom of the last, then the process of sewing will not mould the heavy sole to the shape of the lighter insole, but the latter will be brought to the imperfectly moulded outer-sole; it would not be just to blame either the machine or the operator if such bottoms differ from the shape of the last, for as we have already seen (§ 319) leather cannot be moulded while it is dry, yet how could it be wetted when the boot is made? With the better moulding of bottom stock there would be less complaint of the sewers spoiling the shape of the shoes, and indeed no more should be expected from the levelling machine than that the boot should be restored to its shape previous to sewing.

374. It is very important that the surface of the sole (especially at the channel) should be free from unevenness, since in the process of bottom-scouring the rollers on which the abrasive is fixed cannot adapt themselves to an unlevel surface; hence the high places might be scoured through the grain before the hollow places are reached; this would affect the finishing (chap. xxxvi.) and therefore should be avoided.

The various machines may be classed in three groups:—

(*a*) Those having rollers.

(*b*) Such as exert direct pressure over the whole of the bottom at the same time.

(*c*) Machines using direct pressure, but only on one part of the bottom at a time.

Those in the first class are the least satisfactory, since they often produce very "round" bottoms; for riveted work they should never be used as the motion has a tendency to make the boot less solid. The second class includes such machines as the "Epicycle," the "Atlas," and the "Cyclops"; they are used for the lighter and medium classes of boots, and provided that the forms are correct for that particular substance of forepart and waist, then satisfactory results are possible.

The "Hercules" machine is without controversy the best in the market for heavy work, since the pressure although direct is only exerted on one part of the bottom at a time; the foot on which the boot is placed and the "form" which fits on top of the sole, both have an oscillating motion so that the pressure travels from heel to toe and then back.

375. When channels are cut with a very long lip it is often difficult to cause them to lie down, because in drying the grain contracts and the lip curls up; to minimize the probability of this occurring, after the channels have been wetted and when they are quite free from all surplus moisture, they may have a coat of rubber cement, then when the solvent has evaporated the channels may be laid; with good cement they should be secure, although in wear the thin lip may quickly wear off.

376. An operation which is often omitted, although very important,

is the rounding of the heel seat. When square stock is used for the soles—as for welted work—then the heel part of the sole may be so unlike the heel of the boot that, notwithstanding the use of a guide in nailing the seat (§ 369), it is necessary to shape this part to assist the heeler in putting the heels on correctly. It must be conceded that when the seat of the sole projects more on one side than on the other, or if the soles project uneven amounts at the seat, then it is not easy for the heeler to maintain uniformity of pitch, or avoid the heels inclining to one side. When the seat of the sole has been pieced the "heel-seat rounding machine" is almost indispensable.

CHAPTER XXXI.

HEELS, HEEL-BUILDING, AND HEEL-ATTACHING.

377. HEELS vary in their shape, the following being the description of those at present in general use :—

(*a*) The "Square" heel is used on men's, boys' and girls' boots, but not on women's unless the heels do not exceed 1 inch in height.

(*b*) The "Military" heel differs from the square heel by being more than 1 inch high, the top-piece being smaller and placed further forward. It is not often that this heel exceeds 1⅝ inch in height and its front should be perpendicular to the ground when the boot is being worn.

(*c*) The "Cuban" heel has a top-piece which is shorter from back to front than that of the military heel; it is also placed a little further forward and the front is "cut under" instead of being perpendicular; its height varies between 1½ inches and 2½ inches.

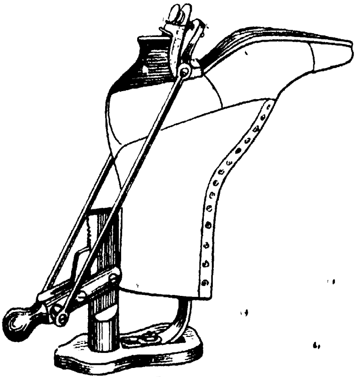


FIG. 136.

(*d*) The "Louis" heel is illustrated in fig. 136; with a special machine the heel part of the sole is split, one portion—the flesh side—is then continued backward to form a foundation for the heel, and the other part—the grain side—is fastened up the front, its extremity being caught underneath the top-piece. The machine shown is used for clamping the leather to the heel while the cement is setting. Sometimes, with kid-covered wood heels, the part of the sole which extends up the front is stitched with silk to the kid covering, but more often the stitching is only an ornament, the leather being cemented up the front.

(*e*) The "Mock Louis" heel is similar to the Louis heel as regards its outline at the back and its shape at the front, but the sole is not split, hence no portion of it is brought up the breast.

378. Heels are not always built in the same way; sometimes an adhesive is used and this may, or may not, be assisted with nails. The

lavish use of paste made from flour cannot be recommended; it is not necessary, and often makes the finisher's work harder since dry paste is very difficult to stain, and it is well known that such heels are more liable to mildew since there is then present something for fungi to feed upon. If in the case of heels having very thin seats it is deemed advisable to take some precaution to ensure the thin edges of the lifts not cracking, then the lifting may be mellowed by dipping it into thin size, after which it should be allowed to drain for at least forty-eight hours before the heels are built. The correct way to build heels so that they do not "check," is to make sure that the edges of the lifts are well compressed; this will not be if the cup at the bottom of the heel is only formed by compressing the centre of the heel, but if the cup is formed by using either of the devices referred to in § 296, then the machine will have an opportunity to compress the external part of the heel with at least as much compression as is used for the most hollow part of the cup. When endeavouring to produce light weighing heels it is often overlooked that the unnecessary material in the centre which requires such excessive compression to form the cup, could with advantage have been saved, since the heel would then weigh less and not have cost so much. The chief argument in favour of using adhesives is that nails are not then so necessary in building the heel if it is to be attached from the outside, consequently the attaching nails would not be deflected through striking one of the building nails.

379. Before describing the building of the heels it is advisable to refer to the methods of attaching them, since the latter governs the former. Heels may be attached from the inside, the nails being driven through the insole into the heel, or they may be attached from the outside, the nails passing through the full height of the heel and forming a bur on the insole. When heels are attached from the inside they must be made solid during the building and compressing; the nails which are used in building must be burred at the point to prevent the lifts springing, but the nails used for attaching the heel to the shoe need only penetrate the heel far enough for security. The heels in this case may also have the top-piece fixed before attaching the heels to the shoes; they may also be breasted and scoured. It is a very great advantage when the last two operations can be performed before attaching the heels, since there would be no fear of marking the shank of the sole with a long seat lift—a mark sometimes difficult to remove. More skill is required to breast heels after they are attached, since there is danger of cutting through the sole, and should the shank be more arched than usual it may also be necessary to finish cutting the bottom lift with the hand knife. It is indisputable that the front of the heel could more quickly be scoured against a cylinder (such as the harder of the two bottom-scouring rollers), than against the cone-shaped, heel-scouring device; the method therefore economizes labour, skill and abrasive. When heels are attached from the outer side, they are not often subjected to so much compression previous to attaching, because few—if any—nails are used, and without nails the heel would not retain the

compression. When these heels have been attached, the top-piece must be nailed on.

Until quite recently the inside attaching was used for ladies' work and the outside attaching for men's, boys' and girls' work, but many firms have now adopted the former method even for low heels.

380. The building of heels should always be done in moulds since it is then so much easier to build a high heel correctly, for if the lifts are placed against the front of a mould and centred by the cup, any quantity of heels could be produced, the lifts in each heel having absolutely the same amount of pitch, and it must follow that if moulds are necessary for high heels then they are advisable for lower ones, even though for the latter they may not be so essential. The employing of moulds enables lifts to be used that are the minimum in size, since each one is correctly centred, and sometimes a visit to the heel-trimming department affords ample evidence that economy could be effected.

381. The lifts in any line of work should if possible be of similar character, otherwise it will be difficult to secure uniformity in colour and burnish; to place different sorts of lifting in one heel is to work on the assumption that all heels could be perfectly finished in the same way, which obviously is a fallacy, for if soft lifts and hard lifts are both put in the same heel, then whatever method may be used, the soft lifts cannot be burnished to look like the hard ones, since the former cannot be excessively burnished without the latter also having the extra burnish and these are more susceptible than the others.

When pieced lifts are used those forming a layer should be uniform in substance, otherwise the heel may be higher at one part than at another, unless it is made level by one part receiving greater compression. The number of nails required must be determined by the number of pieces in the heels, since obviously each separate piece should be secured, but the nails should not be placed where they might interfere with the attaching nails; the nailing as affected by the method of attaching the heels is referred to in § 379.

When the seat of the heel is very thin it is advisable to put the grain of the lift toward the seat of the sole, because when tanned leather dries there is a tendency for the grain to contract, hence the thin edge of the lift would curl in the direction desired, and being the finest in fibre it is firm, whereas if this thin edge had to be produced with the flesh fibres the result might be unsatisfactory.

382. The machines used for compressing heels are very similar in principle; the makers usually urge the claims of their particular machine because of the great pressure obtainable with it, yet upon reflection it may be realized that such excessive pressure is not necessary, since the hand-sewn workman holding the shoe on his lap can build a perfectly solid heel; the secret is the tempering and preparation of the leather, together with the employing of suitable rands, so that instead of the centre the outside of the heel receives most compression; and last, though not least, the nails are only put far enough in from the edge to prevent them showing in the finished heel. If the lifts are very wet when used then

the heels will probably crack, since leather swells with soaking and contracts as it dries.

383. When heels have been compressed those which are to be attached from the inside may have the top-piece attached; this is usually done with a slugging machine, which takes its name from the kind of nail used, it being only a length of wire cut off from a coil without any attempt to form either a head or a point. Wires of various shapes may be used, and the operator can regulate the length of the slug; there is also a device for varying the distance between the slugs, and to regulate the depth to which they are driven; the driver should never be set so low that the slugs cannot be scoured until all the grain has been removed, as this would mar the finish.

Either hand or power machines may be used for breasting the heel, the method being—except for the mock Louis heel—to use a large gouge which has the required curve, then with one cut this shapes the front. Many of the minor details vary with the various types of machines, *e.g.*, the device for holding the heel, device for altering the angle at which the front is cut down, and the mechanism by which sufficient force is obtained to cut it easily, quickly and smoothly, so that little, if any, scouring will be necessary. Another important difference in the machines is whether the breasting is commenced from the bottom of the heel or from the top-piece, with the latter method there is often a difficulty, since the cup in the bottom of the heel would vary with heels of different size, hence a series of rests would be required as supports for the heel when the front was being cut, otherwise the bottom lift would have no support against the knife. When the top-piece rests on the table of the machine and the cutting is commenced from the bottom lift, the cup of the heel is not disturbed, consequently it is left very much smoother than by the former method.

After breasting, the heels can with advantage be scoured, and if the breasting knife is similar in its curve to the bottom-scouring roll, then against this the heels can be lightly held. A fine abrasive should be used and much less time will be required than would be necessary if the heels were first attached to the shoes.

When heels of the Louis heel shape are used, the front will be shaped on a special machine of the heel-trimming type, or on a heel-trimming machine (McKay) which has an attachment for holding the heels, so that the fronts can be shaped on the same principle as the back of the heels.

384. Whether the heels are attached from the outside or inside the method is the same, *viz.*, the nails are placed in a stand or holder (sometimes automatically), and when the heel is placed in position and clamped there the device is set in motion which drives the nails right in. Operators are not unanimous in their opinion as to when a heel should be considered to be straight, but admitting that the front should be at right angles to an imaginary line, should this line be—

(*a*) Direct from heel to toe? *or*,

(*b*) Central between the joints? *or*,

(*c*) Straight through the waist, *i.e.* the heel front square across the waist?

The latter is probably in favour, since although with some sole shapes either method might be satisfactory, yet only the latter could always be depended upon.

385. Machines are provided with a device so that when heels are higher behind than in front there may be similar pressure over the whole heel; where this depends upon an operator adjusting a machine it should never be neglected, otherwise the front of the heel may not fit close to the sole, and the heel may not stand flat through the back being unduly compressed, but when lasts require wedge heels this should be provided for in the building and not be left to chance securing it by compression. The points of the drivers are shaped so that the nails pierce the heel in a slanting direction (for military heels) to avoid the probability of their showing in the finished heel; remembering this they should be placed as near to the edge as circumstances will permit, and sufficient nails should be used to make the heel solid. Round nails with a machine-made head are used for inside attaching. When attached from the outside nails are used which are rectangular in shape, with a dull point and no head; they are not driven in quite level, but left projecting about $\frac{1}{16}$ inch, the top-piece is then pressed on to these, which save it slipping during the slugging.

CHAPTER XXXII.

SCOURING THE HEELS, ETC.

386. For the processes of finishing it is advisable that lasts should be inserted to enable the operator to grip the shoe firmly without incurring the risk of spoiling its shape. Hinged lasts should always be used, since they can be inserted with less difficulty; the last should be similar in design to the one on which the shoe was made, otherwise the waist of the sole may not have sufficient support, or the last might strain the upper into a different shape.

The processes of finishing may be classed under two headings:—

(*a*) Those which increase the efficiency of the shoe.

(*b*) Those which only improve its appearance.

We have already seen that it is a disadvantage for leather to absorb water quickly (§ 259), and that operations which tend to make the leather more impervious to the penetration of water must enhance its utility; nothing however beyond the rolling can be done to that part of the surface of the leather which in wear is subject to abrasive friction, because the part treated would be quickly worn off; but the edges of the soles, which absorb water so rapidly because of the coarseness of the fibre, can be treated to retard the percolation of the water (§ 395).

The welt of the McKay can also be similarly treated; and if the finish of the waist of the sole has the same effect then this should be classed as an operation for utility. Heels of boots are built of several layers, and the effect of wetting and drying is to cause the leather to shrink, and this would enable the moisture to penetrate to the heel-attaching nails, and these being of iron would soon corrode and quickly destroy the nature of the leather, so that it could not hold the nails; the moisture would also cause the nails to rust and by this they would be weakened. When the treatment of the front of the heels is such that it retards the absorption of moisture, then it should be considered a useful operation on goods that are to be worn under damp conditions. It will thus be seen that operations which are for utility on one boot may not answer the same purpose on another should the conditions not call for service.

387. When work is to be finished by machine, ploughing is usually the first operation; the work may be performed either with a "split" plough, a "drag" knife, or an "American plough"; in either of these tools there is some protection provided to lessen the probability of the

upper being cut, but the American plough excels in this respect, it being almost impossible to cut the upper if the blade is correctly set; but beginners often have considerable difficulty with the drag knife. The object of ploughing the seat is to make a true line round the heel by cutting away any overhanging portions; it also enables the shield of the cutter to fit close against the seat where the upper meets the sole; unless this is possible a correctly shaved heel cannot be obtained (for ploughing the forepart see § 393).

The principle of the machines used for shaving the heel is that of a lathe, the shaping tool is held in the machine and the heel brought into contact with the revolving knives. The essential mechanisms include:—

The knives: these are not always on the same principle, some—the "Smith" and the "Ultima"—are moulded to the reverse shape desired in the heel; they are sharpened from the inside and the shape of the trimmed heel cannot be much affected through the cutters being indifferently ground. In other machines—*e.g.* the "McKay"—the knives are flat pieces of steel, sharpened from the outside, being ground to a template, and careless work may result in the shape being altered. With either style of cutter the angle of the bevel on the edge of the knife depends upon the grinding; the operator should observe the difference in the results produced with long or with short bevels, with hollow or with flat: the edge which produces beautiful results on heels built with mellow leather may be very unsatisfactory with wood pulp. When a burr is thrown up on the edge with a coarse grindstone it is an advantage to take it off with an oil-stone, it does not take a minute and the edge will be both keener and stronger. When the blades are ground from the inside they must first be removed from the cutter-head and a similar amount must be taken off each blade, otherwise there will be an unpleasant bumping when trimming the heels; with those machines where the cutter is ground from the outside as in the McKay, the blades need not be removed from the cutter-head, hence the length of both blades will be perfectly true, and the disadvantages of bumping be avoided. In the interests of economy, the knives should be ground as soon as they become dull, it will then not take long, and the work being always trimmed with sharp cutters, the scourer's labour will be reduced to a minimum, and a considerable amount of abrasive will also be saved. Often through a want of thought the corners of the heels are not nicely trimmed; this is to be regretted, especially when the machine is provided with guards which enable this to be done without risk of damaging the upper, whereas there is no guard on the scouring machine. When heels differing in shape have to be trimmed, then if the knives are ground from the inside it is only necessary to remove them and insert others, but if the knives are ground while in the cutter-head it is better to have a separate head for each set of knives, since it economizes time. There is a small guard for the top-piece to fit against, and this may be adjusted so that the knives trim in close to the top-piece or *vice versa.* Similarly there is a guard which enables the seat to be left full, or trimmed close; this will vary with the class of work, it being customary to leave the seat fuller on heavy work than on light work; the nature of the leather must not be overlooked, since in beading the seat mimosa-tanned leather or even oak-bark shoulders may sink considerably.

Sometimes the seat-guard has a swinging motion which enables it to adapt itself to heels which are not quite uniform in height, or to the varying heights of the side and back of Cuban heels.

A randing device may work in conjunction with the bell-guard; these, however, are not satisfactory, except for low square heels, since they do not always rand the seat at the same angle, the latter varying according to the slope of the heel, which at the back is considerably more than at the sides; in consequence of this the back of the heel would be randed at so great an angle that the sole would not fit as close up to the upper as it ought. A separate randing device is generally provided; it shapes the seat of the sole and that part of the heel which comes next to the upper, and when correctly done it is of considerable assistance to the heel-scourer.

A well-made heel seat is the basis of good heel trimming, but when the two sides of the seat differ in shape or there are bumps around it, then the heel trimmer must not be blamed for poor results; as a rule moulded counters produce the best shape heel seat, unless the laster realizes the importance of the operation.

The quality of the work accepted from the machine should be nothing less than the best possible; the scourer can do the work which the trimmer leaves undone, but it will take him longer to do it with an abrasive, hence it causes delay and costs more for time and abrasives. The speed at which the machine is run is very important; the object of great speed is to make the blow caused by the knife striking the heel less noticeable; if the speed is too low there will be a very pronounced series of tappings, but as the speed is increased this tapping becomes less perceptible; there is, however, a limit to the advantage which may be gained, since the speed may cause the whole machine to vibrate and the effect be worse than the fault it was designed to correct. If three knives are used the speed of the machine need not be as great as when only two knives are employed; in the latter case 6000 revolutions of the cutter-head per minute are generally considered necessary.

388. When the heel has been shaved the seat should be mellowed and compressed, or as it is termed "set"; this is especially important when the leather is soft, because at this particular stage it would not cause much inconvenience if the leather yielded more in one place than another, although an attempt should be made to produce a seat that is perfectly shaped, since the scourer would then have two true lines—the top-piece and the seat—to guide him in his work; there is also the further advantage that when the seat wheel is put on the shape of the heel at this place will not be spoilt as otherwise it might be; the operation is very often omitted notwithstanding its importance.

389. The object of heel-scouring is to produce a thoroughly smooth and hard heel suitable either for padding and brushing or burnishing.

The principle of all heel-scouring machines is the same, *viz.*, the heel is held against a revolving, broad-faced wheel, covered with thick felt over which is temporarily strained an abrasive. The wheels should be broad enough that the full height of the heel can be scoured at once, otherwise more time will be necessary, and also more skill, especially when the layers of the heel vary in hardness; the rollers should be so shaped that the form of the finished heel depends more upon the accuracy of the machine than upon the skill of the operator; when heels are curved this is very important, as otherwise uniformity in shape may be difficult to maintain.

Two grades of the abrasive are generally used, that for the first scouring being the coarser; with this the marks of the heel-shaving knives should be removed and any parts which may have been inaccessible to the cutters should now be shaped. Similarly the second wheel with the fine abrasive should remove the marks left by the coarse abrasive and produce a face free from scratches.

The materials which are used for the abrasives vary considerably in hardness and in fineness; in addition to this the foundation also varies. The latter may consist of stiff paper, or in the case of emery it may be of cloth, while some abrasives have a combination of cloth and paper. The first is very liable to tear, therefore the holes made by the spikes quickly work large and the abrasive becomes loose over the wheel; the cloth foundation does not tear, but stretches, and this also results in the strip becoming loose on the wheel; the combination foundation is the best, since it is the least likely to stretch and not so liable to tear.

The coarseness or fineness of the "*grain*" of the abrasive is the result of successive "bolting" through meshes varying in size. In selecting the grades for any particular class of work it should be remembered that the principle of the operation is not a cut but a knock, which chips or tears off small fragments. The materials used for building heels are always less brittle when wet than when dry, consequently it is more difficult to shape them by scouring, in proportion to their dampness, in which condition coarse abrasives would only make deep scratches, while very fine abrasives would only glaze the heel. If a very coarse abrasive is used on the first roll and the material in the heel is hard and tough then deep scratches will be made which will be very difficult to remove with the fine abrasive; but if too fine an abrasive is used for the first roll, the time taken will be long and the cost of the abrasive be high, since fewer pairs could be done without changing. On leather heels it is not so essential that the abrasive be fine, since in this case a nap is produced that prevents the scratches showing; the general principle is, the harder the material the finer the abrasive, since the difficulty of removing the marks will increase with the hardness of the material.

The most suitable motion of the shoe during heel scouring should be studied; sometimes it is easy to see that the motion has not been correct, the most common defect being a flat place on either side of the heel; this is the result of taking the heel in three sections, beginning with one side, then the back, finishing with the second side; it is so easy to apply pressure when scouring the side of the heel that it ought not to surprise us that it results in a flat place. The operator should realize that considerable care was taken when designing the top-piece and its shape should not be altered by scouring, but the only way to avoid this is to go right from one corner of the heel to the other with a continuous swing, which must be carried quite to the corners of the heel.

Often the work of the scourer is made difficult through the excessive speed of the machine. It does not follow that an operator can do more work in a day because the speed of the machine has been increased, since if the rate at which the heel is reduced be increased beyond the capacity of the workman, then he must use more care in bringing the heel in contact with the machine; yet notwithstanding his care he may often reduce the heel too much in some part and thus cause it to be necessary likewise to reduce the other portion, thus the result may be a loss of time. Good results will be difficult to secure when the speed is such that it causes the whole machine to vibrate. The friction which results from excessive speed is also very liable to burn the material in the heels, and to avoid this scorching the operator must use less pressure, the result being that the work takes more time instead of less. It is doubtful if much is gained by increasing the speed beyond 808 revolutions per minute.

390. After the first scouring sometimes the heels are wetted with a solution of iron sulphate; this dries and shrinks the face of the heel, and since when several kinds of leather are used in the same heel one section may shrink more than another, it will be better that this should take place now rather than when the heel is finished, but the heels after wetting must be allowed to dry thoroughly before they can be scoured the second time. Sometimes the object of the sulphate is that it may act as a mordant (§ 400), but for this to be effective it may be necessary to use it after the second scouring and then lightly scour the third time since the mordant must not be scoured off.

When heels are built of loose material they are sometimes given a coating of "filler" before being finally smoothed up; excellent results may be obtained by so doing, because the filler may contain more shellac or dextrine than could be used in the ink without it showing grey. A thinner ink could afterwards be used and only a light application would be required.

If work must be artificially dried, it is a good plan after the second scouring to give the heels a coating of filler, then let them go forward past edge-setting and the bottom-buffer's "drier"; the heels when finished will then be less likely to crack.

CHAPTER XXXIII.

EDGE-TRIMMING AND SETTING.

391. THE object of finishing the edge is to increase the efficiency of the boot by making the edge better able to resist water penetration, and to improve its appearance by compressing it, and giving it a permanent mould. The compressing and moulding is effected with irons which are the reverse shape of the desired edge; a sketch is given of an iron in fig. 137 to facilitate its description. The part between A and B is called the "bed," and it moulds that portion of the edge which is referred to as its "face," it is always measured in 48ths of an inch, the number stamped on the tool being the number of 48ths. There is no standard for the curve between A and B; it is sometimes nearly flat and at other times it is very convex; the latter would produce a concave edge which might be used on a lady's light boot, although being less serviceable and less solid-looking it would not be considered correct for a man's strong boot. Between A and C the line may be quite straight and the angle which it forms with CD may vary considerably, likewise its length above the dotted line. The object of the lip is to assist in restricting the expansion of the edge and to burnish that part of it which is termed the welt. Sometimes there is a little rectangular shoulder on the welt lip as at E, this being termed a "jigger"; it serves no useful purpose except that it helps to make the edge look light. Just by the "jigger" at H there is sometimes a tiny groove, which would set up at the extreme edge a small beading about the size of sewing-cotton; it is known as the "jigger-crease"; there is a similar groove at J, this being known as "the crease"; they do not serve any useful purpose except to define the edges more sharply. Between J and K the "sole-lip" or "sole-guard" may be quite flat, but sometimes it is convex, or it may be concave; should the only useful purpose served by it be to restrict the expansion of the edge when pressure is applied at AB, then the length and the angle of the guard would be at the discretion of the designer, but when it is intended to produce a light-looking edge, the space between A and B may be less than the substance of the edge, and the margin of the sole be bevelled, in which case the bevelled portion would be burnished with this part of the iron, when the length of the lip and its shape would then be important. To enable the tool to be moved backward and forward on the edge without scratching, it must have length-as

at LM—as well as width; but if the pressure were exerted over so large a surface compression would be difficult, therefore it is shaped as at NP; but without this curving it would be difficult to move the iron forward because of the ridge between the compressed and uncompressed portions (§ 396). The tool as already described can easily be "milled" to the desired shape, but it is not yet ready for use, because the iron at ST is as wide as at QR, consequently no part of the iron can be fitted on to the edge until the latter is compressed, but if the lips on either side are rounded off as the dotted line at Q this will give the iron a clearance which will lessen the difficulty of moving it backward and forward, and the edge will receive the maximum compression with the centre of the iron ST. Fig. 137 having two lips would be described as a double iron.

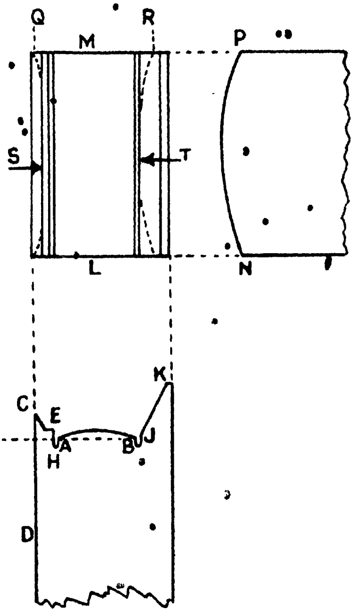


FIG. 137.

392. To facilitate the moulding of the edge with a tool like that which has been described, it is necessary that the edge should undergo some preparation; and that the compression may be uniform the shape of the prepared edge should be similar to the setting iron which is to be used. An illustration of the tool which would be employed is given in fig. 138. It is attached to a shaft and made to revolve

rapidly, the edge of the shoe is then shaped by being brought into contact with the revolving tool. The different parts are known by the same names as the same parts in the forepart iron (fig. 137), but more of the details are registered on the side of the cutter; these include the length of the welt lip (which is only indicated by a number, it being always measured in 32nds of an inch)—varying from "1" to "5"; the angle of the welt lip is the only part that is measured in degrees and specified on the side, hence it is sufficient to put "26°"; in practice they vary between 26° and 45°. The width of the bed measured in forty-eighths is only indicated by the top number as "9". The cutter is made from one solid piece and always has sixteen blades. When sharpening the cutters two things are important; it may be observed in the illustration—but more easily in the cutter—that the cutting edge of each blade is higher than the back of the blade, otherwise it would not cut; a larger circle is therefore described by the cutting edges than by the backs of the blades; if however more is taken off one blade than another, the edge of the blades will not then form a circle, and good work would be difficult because of the bumping which would result. The other important detail is the angle of the cutting edge; if a line is drawn from the centre of the cutter to the cutting edge of one of the blades it will be seen that it differs from the angle at which the blade is sharpened; the angle of the blade as it is in a new cutter has been found by experience to be the most suitable, and when re-sharpening the cutter this angle should be maintained; but this will not be the case unless the post on which the cutter is supported while being ground is moved along as the cutter blades wear away.

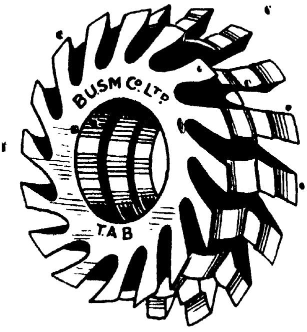


FIG. 138.

Fitting up against the welt lip of the cutter is a circular disc called the "shield," which runs between the upper and the sole, and if the correct size is used it answers the double purpose of preventing the welt lip cutting the upper, and ensuring that the width of the welt is not less than the length of the welt lip, since it keeps the cutter that distance from the feather. The shield should only be just large enough to prevent the blades of the cutter damaging the upper, otherwise the welt will not be properly prepared by the cutter and the stitch wheel may not then be satisfactory; shields are made in various sizes—from 2 to 8—to correspond with the varying lengths of the welt lip and the alteration of the diameter as the cutting blades wear down.

393. In the process of channel-closing and bottom-levelling the edge of the middle-sole may have become curled towards the upper so that the shield of the cutter could not fit into the feather, there-

sult being that only a part of the face of the welt would be trimmed, *i.e.*, the extreme edge, the part next to the upper being too low to be reached; the face of the edge, however, will be reduced to the substance of the cutter by bevelling the sole. To correct these two defects it is usual to "plough" the edge with a hand-plough (§ 387), but the operator must not under any circumstances plough the welt at a greater angle than that of the welt lip of the cutter, because the face of the welt—nearest the outline of the sole—could not then be prepared by the welt lip of the cutter, and the edge would be trimmed less than the full substance of the cutter. The angle of the welt when ploughed should be between 10° and 15°, so that the shield can run in the feather where the upper meets the sole; the welt lip of the cutter should then prepare the face of the welt and make any further reduction which may be necessary.

Sometimes the edge-trimmer is required to use a smaller gauge cutter than the substance of the bottom calls for, in which case the correct thing to do is to use a cutter which has the welt lip at a greater angle (say 45°), the middle-sole is then reduced instead of the outsole. If combination or self-wheeling irons are used, the angle of the welt lip on the cutter must agree with the angle at which the wheel is set in the combination iron and the welt lip of the cutter should prepare the full width of the welt.

394. The operation of edge-trimming should do more than prepare the edge so that it could be compressed and burnished; it should also correct some defects in the irregularity of the width of the welt, which may be caused by one upper being stouter than another, or possibly one sole may have been placed farther over the toe than another; sometimes the soles do not correctly fit the last, or in attaching the sole it may have slipped to one side; the operator should endeavour to correct these defects, but should never reduce the sole more than is necessary.

The successful trimming of an edge probably depends as much upon the suitability of the condition of the work as upon the keenness of the edge of the cutter. When a knife is used by hand, the action is on the principle of a very fine saw, but when an edge is trimmed by machine the principle is that of a blow with a keen-edged tool. The resistance varies according to the nature of the leather; a piece of mimosa-tanned leather does not offer as much resistance as oak and valonia would, but notwithstanding its resistance it must yield, although the results will differ, since the latter partakes more of the nature of a tear, and if the edge is examined with a magnifying glass it will be seen that it is coarse, whereas the mellower leather which offered less resistance to the cutter is comparatively smooth. Since the trimmed edge will be coarse in proportion to the comparative hardness and coarseness of the leather, it is usual to counteract its natural hardness by obtaining an artificial mellowness with wetting; it is, however, advisable that after wetting the edge should be allowed to stand so that the fibres and tanno-gelatine may absorb the moisture, and the quality of the result which can then be secured justifies the extra labour entailed.

There is, however, a limit to the mellowness which is useful, for if the leather is made so soft that it cannot stand against the cutter then the shape of the trimmed edge will be unsatisfactory. When work is to be finished square-to-heel it can with advantage be trimmed before it is heeled; usually, however, either one or both of the sides of the waist are rounded, and generally it is found necessary to finish with a hand knife that part of the waist which is by the heel.

395. With the object of further improving the appearance of the edge and helping it to retain this appearance in wear the edge must be made more solid and more waterproof, for as left by the trimmer edges are too soft and open, they quickly absorb water and then lose their shape; to overcome these tendencies the edge is compressed and burnished. "By compressing the edge we mean that the fibres and the substance which fills the spaces between them are forced into a smaller compass, the tool employed being the setting iron already described (§ 391); this is moved backward and forward upon the edge, considerable pressure being used, and thus the face of the edge is compressed; but should the iron be too convex then only the centre of the edge will be compressed; if on the other hand it is not sufficiently convex then only the margins will receive the compression, the centre of the edge being untouched. In addition to the compression which can in this way be obtained it will be noticed in fig. 137 that there are two flanges, or lips—one to fit on either side of the edge of the sole; these are important, for the face of the edge rather than allow itself to be compressed increases in thickness; these guards, however, limit its increase in width, and so, being unable to expand further, it yields to compression in this direction (thickness), and is finally obliged to yield also at the face. This compression in the double direction to be satisfactory requires not only that the bed of the iron agree with the face of the edge, but also that the angle of the welt lip both on the cutter and on the setting iron be the same, and likewise the angle of the sole guard on both cutter and iron; more attention to these details would considerably lessen the edge-setter's work.

396. The impossibility of compressing leather while it is dry has been considered in § 260, and it is equally true in edge-setting; whoever therefore would successfully set an edge must first bring the leather into suitable temper, otherwise recourse must be had to filling the coarse edge with wax, or the body of a heavy ink; yet even then the result will not be equal to that which is attainable when the fibres and tanno-gelatine are in a suitable condition for moulding. It is possible, however, for the leather to be too sodden, when it would not be able to stand against the pressure, consequently the edge would be pushed out of shape and the friction would cause the tanno-gelatine to be worked out of the edge.

Friction plays an important part in edge-setting, it is usual to commence at the joint and work towards the toe, only a small portion should be moulded at a time, this through being compressed will be a little lower than the other portion, and as the iron is being continually

CHAPTER XXXIV.

INKS AND MORDANTS.

399. THE inks used in finishing have three functions to perform: (*a*) to colour; (*b*) to fill; (*c*) to assist the polish; and there are three typical inks in the market.

(1) *English ink* is a dye having very little—if any—body, hence it is a clean ink to use since there is not any "bloom" to smudge; but it does not fill the leather and consequently it will be necessary to iron in a wax for this purpose. It is very useful for shoes that are to be finished with a brown welt or coloured bevel.

(2) *American* or *Edge-ink* is both a stain and a filler; it has abundant "body" which quickly precipitates if it is allowed to stand, and when it is applied to the boot the ink dries, leaving on the surface a heavy bloom of a dark blue colour which easily rubs off, whence it is not a clean ink to use; the bloom when ironed in fills the edge and gives it an appearance of solidity, but heat is necessary to develop the colour of the dye.

(3) *Quick Black* or *New Process ink* is more on the principle of a paint; it is not a dye and therefore after it has been applied to a smooth surface it could be wiped off without leaving much trace of its visit; when dry it adheres firmly, and it is then capable of receiving a high polish, but it must be allowed to dry thoroughly before anything can be done with it; heat is not necessary to develop its colour, therefore for stitched welts that are to be finished black it is very useful.

400. Any of the above inks when made by different makers will differ very much both in composition and quality; in addition to this the results which can be obtained with any ink will be modified by the conditions and method of using.

All leathers cannot be stained with equal facility; English ink for its staining power depends largely upon the presence of tannic acid in the leather; therefore one could not write with it upon paper; it is useless, however, for chrome-tanned leather, yet with pure bark-tanned mellow leather it may be perfect, although that same ink may not be sufficiently penetrating for dense hemlock leather.

When any particular leather is difficult to stain it is not unusual to accept the service of a mordant, which is a substance in solution that has greater chemical affinity both for the leather and the stain than the stain has for the leather; it therefore forms a connecting link or bridge between the two. Leather that is "starved," or only partly tanned, does not stain easily because of the small amount of free tannic acid present, under such circumstances it is an advantage to mordant the edge with a solution of tannic acid; this quickly penetrates and the iron in the ink acting on the tannic acid at once stains the leather. Mordants are not necessary when *Quick Black* is used.

When the leather is too dense for the ink to penetrate it, then weak ammonia can be used with advantage, but if it is used after the first setting it has a tendency to cause the fibres to spring, thus causing the edge to be open. Should the leather be greasy, it is very useful, since it changes the grease to a soap.

Both ferrous sulphate and copper sulphate are used, and either readily combines with the free tannic acid in the leather, thus causing the edge to be dyed considerably below the surface; ammonium ferric sulphate is, however, much to be preferred, being more powerful. The regular use of a mordant ought not to be necessary, since it involves an extra operation, and if similar conditions always prevail a suitable ink could be procured, but when odd lots of leather are purchased and the ink in general use is not satisfactory, then it may be an unavoidable expedient.

401. When determining the method of treating the edges it should not be overlooked that they are much more difficult to stain after they have been compressed and made solid, especially if the nature of the fibres has been changed through using heated irons, and while with some leather no inconvenience may be experienced, yet with other leather and double setting it is an advantage to mellow the edge with a mordant rather than clear water; sometimes, however, a special ink is used. Leather varies so much that even the method of applying the ink which may be satisfactory with one leather, or with one ink, may require modification when either is changed.

Leather which absorbs freely would take up so much dye that it is soon stained, and if the hard close leather could be made to absorb a similar amount, that might also be stained; therefore it may be stated that the staining power of an ink will be modified according to the amount absorbed; and because of this, leather that is hard takes longer to ink if it is to be satisfactorily dyed.

The staining power of an ink often depends upon its body, but because of the closeness and hardness of some leather it is impossible to work into the edge enough of it to stain the edge; in the process of ironing this heavy bloom is only shifted from one place to another until it is removed by the "rubbing off"; a large quantity of heavy ink is not suitable for such leather but an ink that is more penetrating and with less bloom should be used; soft and badly filled leather, however, requires an ink with much body, otherwise to obtain sufficient of this residue to fill it satisfactorily so much ink would have to be used that the edge would become sodden.

A uniform quantity of ink should be applied to the edge, which would be sufficiently inked when, instead of absorbing it, a residue is left on the surface; if the edge is not evenly inked one part will dry quicker than another and the result be very unsatisfactory. The brush selected should be very soft since it will hold a larger quantity of ink and also be less likely to splash when the hairs spring back to their normal position after having been bent against the edge. The method of trimming often affects the results which are attainable with any ink (§ 394); if a dull cutter has been used or the edge been trimmed when dry it will be so coarse that an ink with more body will be desirable.

Inks that have much bloom depend entirely upon the presence of moisture and the application of heat for the development of the colour of the dye; if all the moisture is allowed to evaporate before the edge is ironed then the colour will not be improved with heat, and if sufficient moisture is present, but the iron nearly cold, the temperature of the moisture will not be raised sufficiently to develop the colour fully. There must not, however, be too much moisture, as then the filling in the leather would be mixed with the ink to the detriment of the colour of the latter; moreover while the leather is full of moisture the sediment of the ink cannot be forced in, neither will it adhere to the saturated fibres of the leather, and consequently it becomes attached to the face of the iron and sets up a series of scratches until the tool is cleaned.

402. To ensure an even coat of ink being applied to the heel a soft camel-hair brush should be used; an expert workman may do passable work with a poor brush, but with a better brush even he would probably be able to do better work and more of it; when one thinks of the number of heels that would be inked with one brush, and the difference in the result obtainable with a good one as compared with a common one, it is surprising that customers are found for some of the brushes which are sold for the purpose.

Quick black is generally used on the heels, but it is difficult to ink the seat where it touches the upper without sometimes letting the brush glide over the upper, and because of its adhesive power the black is very difficult to remove afterwards; therefore on the better classes of work it is not at all unusual to use a special dye just around the seat, and a brush would be used similar to that used on the edges of the forepart (see § 409).

CHAPTER XXXV.

THE FINISHING OF HEELS.

403. THE methods of finishing heels by machine may be divided into classes as follows :—

(1) Where a heated iron tool is used.

(2) Where a revolving pad is used, the heat being supplied by the friction of the pad on the heel.

(3) Where a pad is used as in group 2, there being in addition a device for melting the wax.

In the first group many devices have been tried but not with much success, so that only one machine, the "Expedite," remains in general use. The principle of the machine is that of a revolving wheel, having on its thick edge twenty-four plates arranged in spiral form, each plate being somewhat convex—so that its edge shall not damage the heel—and mounted on separate springs to enable it to adapt itself to the shape of the heel ; the plates are heated with gas.

An argument which may be advanced in favour of this method of finishing is that it permits the use of an ink which can be burnished while it is mellow ; this is a great advantage, since such ink is more penetrating than *Quick Black*—which is very liable to wear off and leave the heel uncoloured ; it has also been seen that leather which has been subjected to sufficient heat undergoes a change which causes it to be more water-resisting than it otherwise would be ; and in addition to this the edge of the heel being subject to such heat and friction while it is mellow can be rendered more solid and more permanent than is otherwise possible. Leather board and wood pulp cannot be ironed when they are mellow, therefore *Quick Black* must be used, and being already sufficiently solid they do not need further compression ; consequently the foregoing arguments do not apply ; they are only applicable to leather heels.

404. The second class is often described as the "Friction" method, since the *Quick Black* ink which is used contains an adhesive and this coating of ink is susceptible of a very high polish by friction. It is only a process for polishing heels that are already sufficiently smooth and solid, consequently the quality of the finish will depend principally upon the scouring, next upon the quality of the ink and how it is put on ; if these are satisfactory the polishing will not be difficult.

405. Much depends upon the pad ; its shape should be as near to

the shape of the heel as possible, since this would lessen the difficulty of ensuring that each part of the heel received a similar amount of friction; and in addition it would effect an economy in time, because when the heel was placed against the pad more of its surface would be in contact. The pad should be sufficiently solid that suitable friction can be set up, but it should be flexible enough to allow it to adapt itself to the form of the heel. Sometimes the pads are made from felt, in which case they would be covered with a fabric, or specially woven cover, the "Riley" patent cover often being used.

Sections of cloth have been employed, and over these a cover would be used as with the felt, but when sections of leather are used this would not be necessary. Leather pads need more care than those which are covered, since an extravagant use of wax may soon result in the pad being choked, when it loses its flexibility and its utility, whereas to replace a "Riley" cover which was overloaded with wax that had lost its nature would not be difficult. When selecting pads the cost of the covers must not be overlooked, neither must the "first cost" nor the durability be ignored. The amount of flexibility desirable in the pad will depend upon the quality of the ink and hardness of the wax; as a rule low-priced inks have but poor holding power, therefore a softer pad must be used to save the friction removing the ink from the heel; a soft pad however would not generate sufficient heat to soften a hard wax, hence the latter makes necessary both a good quality ink and a firm pad; whereas common ink can only be used successfully with a relatively soft wax and flexible pad.

The usual method of padding a heel is first to bring a cake of wax into contact with the pad, using sufficient pressure that the wax leaves the cake and adheres to the pad; the heel is next applied to the pad and the absorbent surface of the heel soon becomes covered with the wax, because the latter has more affinity for the colder heel than for the hotter pad. The heel should be perfectly covered with a very thin film of wax, more than this is a waste, since the wax cannot be polished to look equal to the inked surface of a heel; it also involves extra labour since the excess must afterwards be removed. The motion of the boot in padding should be the most suitable to secure the desired result, hence it should be similar to that used in heel-scouring, the swing being from heel-corner to heel-corner. The amount of friction set up will depend upon three things, the elasticity of the pad, the pressure used, and the speed of the machine. When the speed is excessive the operator cannot use sufficient pressure to cause the pad to adapt itself to the shape of the heel without setting up so much friction that the ink may be removed from the heel or the wax be burnt by the heat that is generated. On the other hand if the speed is inadequate so much pressure must be used that it will cause a strain on the pad and also take longer to do the work. Usually a speed from 800 to 1200 revolutions per minute is satisfactory.

406. In the third class of machines a device is employed for using both a pad and heat. In the "Copeland" machine an asbestos roll is

used, this being heated with gas; the wax is held in a pocket and can be brought into contact with the roller by pressure on a pedal; for the best results the pad should be similar to the shape of the heel. The advantage claimed for the machine is that harder wax can be employed on the heel. Quick black ink is used.

The waxing wheel of the "Harlow" machine is of iron and is made to open with a hinge; the wheel is covered with felt and over this a piece of drill is strained—as is the sandpaper in a heel-scouring machine. The heat is generated by a steel piece which fits on the wheel with an adjustable pressure; and there is also a device for supplying the wax. It saves the expense of gas, and allows the heel to be covered with a hard wax without risk of removing the ink.

In the "Apex" machine both the wax-pot and wax-wheel are heated by steam, thus saving the expense and unpleasantness of gas and wear on the pad covers.

407. When the heel has been covered with wax it must be polished by removing the excess; it is usual to do this on a brush fixed to the same shaft as the pad. When the brush is too hard for the ink and the wax then the heel will be stripped, and in consequence it will be poor in colour; but if it is too soft, extra pressure must be used; this will cause considerable bending of the bristles which may leave bad marks in the wax on the heel in addition to causing the brush to become very dirty.

One of the commonest faults of heel padding is the use of an excess of wax; when this happens to be a very hard wax put on with one of the machines discussed above in § 406, then it is difficult to soften and remove it with the brush, and consequently such heels do not look as smooth as when they left the scourers; obviously nothing can be gained by using such hard waxes, it would be much better to use a wax sufficiently soft that without undue bending of the bristles any slight surplus could be removed; a little good quality fake should then be applied, after which with a soft brush and a light touch finish the polishing.

408. Waxes used for padding (black) differ considerably in depth of colour, some being so grey that they detract from the appearance of a good ink; bad colour wax is dear at any price. Waxes also differ as to their melting-point; the wax which is considered to have the best polishing property being the hardest—*Carnauba* wax. This is usually softened down with cheaper and less suitable waxes, the disadvantages—in addition to loss of colour—being that the heels may have a greasy appearance and a tendency to show every finger-mark; this effect would result from using cheap beeswax; sometimes resin is used to such an extent that the heels are quite sticky. If a piece of string is held firmly and drawn across some pure *Carnauba* wax and a similar piece of string is then drawn across a common wax adulterated with resin its stickiness will be very noticeable.

409. Fakes are usually purchased ready for use; they consist of wax—more or less pure—but reduced to a pasty consistency. Two classes of fake are in general use; in one class the solvent is turps, and is very

useful on inks or "Russet" because it helps considerably to brighten up the colour, and the turps being so penetrating, it softens russet and thus assists in the production of highly polished surfaces. For "Oak-line" or painted surfaces fake should be employed in which the solvent is less penetrating, soap being often used, for it hardly affects the colour if properly applied, and it is less likely than turps to destroy the adhesiveness of the paint; it can be used on ink or russet but the results are less satisfactory than with the turps fake; but if a russet is used for the waist and a paint for the forepart, a soap fake should be employed for both. Fakes are made both in black and in white; one could not use a black fake on a coloured bottom without soiling it, but a white fake can be used on black without detriment; therefore if a boot is finished with a black waist and russet forepart a white turps fake should be used on both; but if the forepart were painted, a white soap fake would be used on the black waist, lest a turps fake should spoil the paint or a black fake be smeared on to the light forepart.

In edge-setting it is an advantage to use a little wax in the form of a fake for filling the edge, since it is more readily applied, does not require so much heat to iron it in, and the excess is more easily removed (see § 402).

CHAPTER XXXVI.

FINISHING THE BOTTOMS.

410. SCOURING the bottoms has a twofold object, the more important being the preparation of the sole surface for the after-processes of blacking, painting, or otherwise finishing; the second object is to make the bottom quite level, since even slight irregularities detract from the quality of the finish. Sole-leather consists of several layers, three of these may be finished, but they are not equally suitable; the hyaline layer is too close and hard, and can only be stained with difficulty. The middle fibres are coarse and open and cannot be satisfactorily finished by either of the regular methods. The grain fibres which come between the hyaline layer and the middle fibre hold an intermediate position as regards fineness, and form the most suitable of the layers for either of the finishes. It is very desirable that in the bottom scouring only the hyaline layer should be removed, but the dents and unlevel places are often so difficult to reach that in the attempt the grain is scoured away; under such circumstances one has to choose between two evils; either the hyaline layer must be left in the low places or the grain must be scoured through at the high parts (see § 413).

411. The principle employed in all bottom-scouring machines is that of a horizontal rotating cylinder covered with an abrasive; sometimes the rotary motion is supplemented with a reciprocating one, the latter being at right angles to the former, this is an advantage, since there is then no probability of the pronounced scratches which otherwise often show.

There are many varieties of surface to the cylinders including the following:—

(*a*) Split cylinder, which opens like a heel-scouring wheel, covered with thick felt.

(*b*) Circular sections of leather set at right angles to the shaft; they furnish a very unyielding surface and are generally only used for the coarse scouring.

(*c*) Leather sections are sometimes arranged parallel to the shaft, when they furnish a very yielding surface, hence the use is restricted to the fine scouring.

(*d*) Flanges of rubber passing around the cylinder in spiral form are sometimes used for the fine scouring.

412. A consideration of more importance than the type of cylinder

is the grade of abrasive used. Generally two scouring rolls are employed, one having a much coarser abrasive than the other, this economizes time, since the rough surface can more quickly be removed; but the abrasive must be carefully selected, since if it is too coarse the marks (especially on a hard leather) will be difficult to remove with the fine abrasive. Leather must be quite dry to be buffed; often the operator is supplied with an apparatus for drying the bottoms, but artificial heat does not improve vegetable-tanned leather and therefore it should be avoided if possible.

On account of the size of the roller it is impossible to scour the waist of the shoe nearer than two inches from the heel; this necessitates the use of a "Naumkeag," which is a rotating perpendicular spindle, to the bottom end of which is attached a circular horizontal pad covered with an abrasive, emery being generally employed. To do this part of the bottom with so fine an abrasive takes longer and costs more proportionately than the rest of the bottom; to obviate this expense the bottoms of boots may be scoured before heeling, when, as in the case of welted work, the last is still in the boots after channel closing, as could also other work if it is sufficiently stout that the bottoms could be scoured without a last being inserted. It is not a good policy to continue using an abrasive which is so much worn that extra pressure has to be used, since there would then be great probability of burning the bottom.

The slugs whether in the heels or in the foreparts should be ground down on the flat side of an emery wheel, a machine for the purpose being on the market, which could also be used for the grinding of tips; the economies of abrasive and time soon repay the cost of the machine. It is very important that when the scouring is completed the shoe should be thoroughly brushed, since carelessness may prevent good results in succeeding processes.

413. The bottom of boots may be finished in several ways and many styles; probably the most popular method is with "Oakaline" or paint; the preparation when used is of a creamy consistency, this is "floated" over the bottom in such a way that after the absorption or evaporation of the liquid part there will remain a thin opaque film, even in colour and without brush-marks; the impression conveyed by the finished surface should be that good leather has been used, and both a plastered appearance and an enamelled polish should be avoided. To secure this effect is not always easy, since the result depends upon so many factors; as already remarked the paint must be *floated* on, that is a sufficient quantity must be used that the bottom is covered with the liquid part, but this is very quickly absorbed and as the leather sucks this in the body of the paint is also drawn in with it. The film, however, is so thin that it does not cause the sole surface to be any more level, although it is not necessarily uniform in thickness, for should the liquid in one part not be absorbed as quickly as in another part, then the portion that has already absorbed its share draws the paint from the other portion; therefore if one part of the sole has the hyaline layer on,

and another part is scoured through the grain, the film on the former will be much thinner than that on the latter, and this together with the difference in the coarseness of the fibre in the two places causes the result to be very unsatisfactory. When the painted bottoms are bad, it does not follow that it is the fault of the one who painted them; it may be necessary to trace it back to bad bottom-levelling, which made it impossible for the buffer to avoid scouring through the grain (in places)—hence the poor result.

414. Both the appearance and the holding power of any paint are modified by the character of the leather on which it is used; its holding power depends partly upon its absorption, and if two soles are painted, one being cut from a close fibred hemlock, and the other from a piece of shoulder, then, when they are quite dry, in trying to clean off the paint it will be found that because the body of the paint could not be sucked into the hard leather, it can easily be removed, whereas the body has been sucked into the pores of the shoulder sole, and hence it is difficult entirely to remove it. To secure the best results on differing kinds of leather, some difference is desirable in the paints that are used, the leather which is very close and not absorbent requires a paint with but little body, yet having good adhesive property; while on leather that is soft and absorbent there should be sufficient body to prevent rapid absorption and to fill the leather. Much depends upon the skill of the workman, one is nervous and moves slowly, another is confident and moves quickly; the latter will be able to obtain satisfactory results under conditions which, to the former, would be quite insurmountable. When the leather absorbs so rapidly that it is difficult to secure satisfactory results, a small quantity of *Gum Tragacanth*, after being soaked in cold water for twenty-four hours, may be dissolved with a moderate heat and added to the paint. Sometimes one is expected to finish satisfactorily soles that have been cut from stout splits; this difficulty may be overcome by adding a larger quantity of the gum to some paint—any that may be handy if the shade is not too dark; then when it is quite dry scour it smooth with fine abrasive; by this method the pores are filled, and only a very light application of paint will now (after scouring) be necessary to ensure an excellent result. Either dextrine or glue may be used instead of gum, but the last is the easier to scour. Suitable brushes are indispensable; they should be sufficiently wide, and made with long camel hair, but it is a disadvantage when there is too much of it. When painting the forepart in two-colour finishes the brush should first be worked from heel to toe and then transversely, since when done this way there is less difficulty in making a true line where the waist and forepart meet.

415. If when the paint is quite dry it were left without anything further being done to it, then it would not be a suitable finish for shoes, since it would so quickly soil; to correct this and further to improve its appearance, it may be finished off in either of the following ways:—

(*a*) Dusted over with French chalk and then polished with a soft cloth.

(*b*) Suitable fake (§ 409) applied to the painted surface: it would then be polished with a soft cloth after the absorption or evaporation of the solvent; in practice it would be polished on a soft power brush.

(*c*) After faking, the surface may be boned; if the soles are cut from soft leather this will make them appear more solid, but it is too expensive for wholesale manufacture.

(*d*) A soft felt roll may be covered with silesia; this would be lightly waxed with suitable wax, and the painted surface applied to the roll; the pressure used must only be sufficient to soften and spread the wax without darkening the paint; this may subsequently be faked and brushed to a polish.

(*e*) An improvement on the foregoing is to apply the wax to a power brush, since there is less liability of burning, besides which a smaller quantity of wax is used, and it is more evenly applied.

There is such a tendency for the paint to darken in colour when it is heated, even by friction, that it is necessary to select the brush very carefully, since the heat generated will somewhat depend upon the resistance of the bristles; if, however, the brush selected be either too thin or too soft it will then be necessary to increase the pressure, which would also generate heat; in addition to these there is the speed of the brush to be considered, since when this exceeds 800 revolutions per minute it will be difficult to prevent the surface being darkened.

Cleanliness is necessary; the brush removes from the painted surface small particles of the paint and this adheres to the wax which is on the brush, and since there will also be some dust from the atmosphere which is attracted to the brush it follows that it will be advisable from time to time to use soap and water to wash the brush.

It is quite easy to increase one's difficulties by using the wax too liberally, since the special wax prepared for the purpose has been softened; but when applied to the sole, or left exposed, this solvent is soon absorbed, or evaporated, after which the wax is much harder; even the friction of the brush assists this evaporation, but it will now be much more difficult to remove the excess of wax, and the pressure required to soften it sufficiently generally produces a stain; therefore the smallest quantity that will produce satisfactory results is all that should be used.

It is very important that sole surfaces should be quite dry at the time of painting, otherwise there will be unequal absorption which may cause a stain. Paint quickly draws the grease out of a sole, therefore when leather is known to be greasy it should be bleached before painting.

416. In using gum finishes the surface must first be buffed and then sanded, after which if necessary it can be bleached; *Gum Tragacanth* can be soaked in cold water for twenty-four hours, then pour off the excess of liquid and beat up the gum, which in this form may be worked into the sole surface with a sponge or flannel, using a circular motion; otherwise the gum may first be tinted, using any aniline dye; there is only one way effectively to finish off these surfaces, and that is to bone them, but even this must be done while the gum is still plastic;

the result then will be a hard smooth surface, but if the gum is allowed to become quite dry it cannot again be softened, neither will it be improved by boning.

The same gum will not always produce the same result, its colour often being modified either by the colour or nature of the leather, for should it be hard it will absorb so little that the colour of the leather may scarcely be altered, whereas a soft leather, because of its absorption, may be deeply dyed. Sole scouring is more important than it would be for painted surfaces, since if one part is left more coarse than another even this would be apparent. The gum will not hide stains but rather accentuate them, therefore they should be bleached out if a clean finish is important.

417. The term *Stains* is used to include both stains and dyes. Anything which produces a colour different from its own colour is a stain; whereas a dye produces an effect similar in colour to the dye itself. These stains may be applied with a sponge, a brush, or a flannel, and for convenience may be grouped as follows:—

(1) A simple liquid stain, the sole object of which is to produce some particular colour. The advantage of colouring the soles in this way is that the stain is so much more penetrating that even very hard soles can be successfully coloured. The stained surface may now be gummed—the gum used may be sufficiently thin that it can be applied with a brush, and when in condition it may be boned. Sometimes the bottom, after receiving a coating of gum, is immediately brushed on a soft power brush; while it is still soft gum has high polishing properties, but not when it is dry; the bottom should now be rolled, using polishing wax, after which it can be faked and brushed.

(2) The stain may have a body of *Gum Tragacanth*, it will not then be so readily absorbed by the sole surface, and the gum being used much thinner than the gums referred to in § 416 is not too hard to be finished off with rolling and brushing.

(3) Sediment stains differ from those in group 2 in that they contain an opaque sediment; they are very useful on soft leather, since the sediment, which is only just sufficient for the purpose, fills the surface of the leather, thus producing an excellent appearance of solidity. They may be finished almost immediately by being brushed to a dry stained surface, then rolled and polished, but unless the bottom is all one colour the stain may be brushed over the shank mark; they are usually applied either with a sponge or flannel.

(4) Transparent stains do not contain an opaque filler, and since they do not hide any previous stains they are only suitable for clean, good leather.

(5) Brush stains are such as can be entirely finished off by the power brush.

(6) Double brush stains. After the first coat is dry, with these a second coat is applied; for some shades it is the best way to secure an even colour. They can be entirely finished on the power brush.

Greasy soles should first be bleached, the transparent stain then produces the best results, since the gum and wax do not draw the grease to the surface as the sediment would. A soft wax should be used and the bottom only rolled lightly.

418. Russets differ from stains in that the body is composed partly of wax; the mixture is used in a similar way to paint, but its particles have greater cohesion and the film left after evaporation is thinner. Usually they are dark in colour, and are often used when the leather is too stained for the lighter finishes. It is the most suitable finish for greasy soles. Russet finishes do not chip, neither do they soil with handling; they may be finished off as follows:—

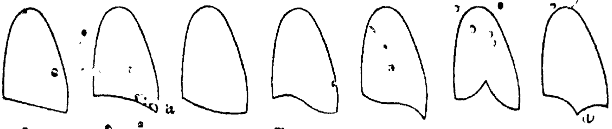


FIG. 139.

(*a*) Brushed with a waxed brush and then polished.

(*b*) Rolled and then polished.

(*c*) Boned and polished.

(*d*) Burnished with a warm burnisher, either by hand or machine. Russets can be used on the heels and edges of coloured work, in which case the heels may be finished with pad and brush, or with hot kit. Turps fake produces the best results, since it softens the russet and also improves the brightness of the colour.

419. *Styles of finish employed.* Bottoms may be finished all over with either of the finishes to which reference has been made; for convenience these will now be referred to by letters as follows: A—Black bottom; B—Painted bottom; C—Russet finish; D—Gum finish.

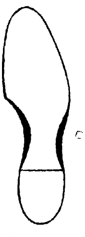


FIG. 140.

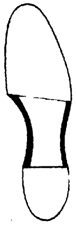


FIG. 141.

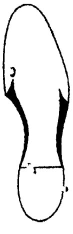


FIG. 142.

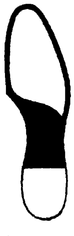


FIG. 143.

A black-bottom finish may be modified by the forepart being finished in either B, C, or D style; and this may be varied still further by altering the design of the waist which may take either of the forms shown in fig. 139.

Painted bottoms may be modified with the addition of a "strip" or strips; fig. 140 illustrates the half-round strip; fig. 141 the square strip; fig. 142 the short peak strip. Painted bottoms may also be varied by using on the forepart a paint of a lighter colour than that used in the waist, selecting for the dividing line either of the designs shown in fig. 139. In addition to these variations either the half-round or square strip could be used.

Russet finishes may be varied with either B or D forepart, or with a russet of a lighter shade or different colour, or the addition of either the half-round or square strip.

Gum finishes may have a painted forepart or either the half-round or square strip.

When either B, C or D is used on the forepart, its edge may have a narrow, coloured border, often described as a "top-iron"; machines are supplied with devices for melting and spreading this on the edge; for the latter a wheel with a flange is used.

Sometimes this narrow strip is increased to ¼ inch or ⅜ inch, in which case it would be described as a "border"; this is often a useful finish when the channel is bad, although to make it effective it is generally necessary to surmount it with a "bunker" which makes a series of impressions around the edge—often only a number of short lines the full width of the border and at right angles to its edge, but various designs are used.

When the forepart differs from the waist the place of meeting is often surmounted with a "crow" wheel (various patterns are in use); this makes a series of fine indentations which often hide little imperfections.

420. The "fudge wheel" may be put on at the time of edge-setting (§ 397), or a hand tool may be used, in which case it should follow the compression of the edge previous to ironing in the wax, since if the fudge wheel caused the edge to crack—as it sometimes does—then the ironing in of the wax would probably correct it. The wheel should be a suitable width for the welt, but not so wide that the impressions mar the edge, and the number of impressions to an inch should be in keeping with the character of the boot. Around the heel—where it meets the upper—a series of neat impressions may be noticed; these are made with a seat-wheel and at the same time the seat is "set" or "beaded"; the width of the row and the number of impressions to an inch should be carefully selected; a narrow wheel with many impressions would not be suitable on a man's heavy boot, neither would a wide one, and few impressions add to the attractiveness of a lady's light shoe.

421. It is of the utmost importance when designing a boot that the effect of the finish should be in keeping with the character of the boot: the effect of lightness, neatness, daintiness, strength, solidity or usefulness may each be expressed with the finish.

A black bottom looks heavy; it may be neat, but it is not artistic; it gives the impression of solidity rather than beauty; it is sometimes used on ladies' light work but should be considered "out of keeping". The effect of a paint will be modified by its colour; when it is only tinted the effect would be that of cleanness, lightness and neatness, it suits ward shoes and slippers, but it would spoil the appearance of a shooting boot.

The effect of a gum finish when the bottom is finished with only one colour will depend somewhat upon the tint, but usually they convey the impression of solidity and usefulness.

Russet finishes always look heavy; they may sometimes convey the impression of neatness, but rarely do they look artistic.

When the bottom is finished in two colours two impressions may be conveyed; the black or dark russet waist conveys the impression of usefulness, but the light tinted forepart makes one feel that strength and neatness are not irreconcilable, and this may be emphasized by the design of the waist; the straight line looks the heaviest, and the most pronounced double curve is certainly the most dainty.

The most artistic finish is the coloured gum waist marked across with the double curve, the width of the waist being reduced with the half round strip and the forepart painted with a tint that blends with the colour of the waist. Yet even this finish may be spoilt with the top-iron which is often more gaudy than artistic. It may be employed to deceive the eye as to what is the full width of the sole, or it may be so conspicuous as to attract attention to that which it endeavours to hide. The blending of its colour is very easy, waxes being procurable in a variety of shades, and the pleasing effect may often assist a sale; it should never be lost sight of that not one per cent of retail customers have the slightest idea of value in a shoe, apart from its fit; and sometimes even more important than this is the impression conveyed by the finish, especially in the more dainty classes of ladies' footwear.

APPENDIX I.

LEVERS.

LEVER is generally defined as being a rigid rod capable of turning about a ixed point called a fulcrum; they are often used to obtain a mechanical advantage, since it is possible with them to move a weight which we could not otherwise move.

Levers are classed in three orders according to the relative position of he *fulcrum*, the *weight*, and the *power*.

FIG. 1.

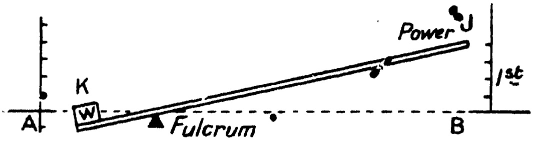


FIG. 2.

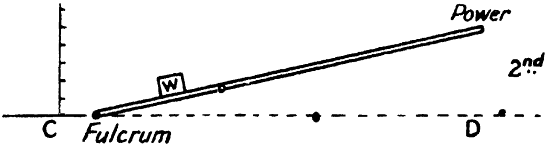
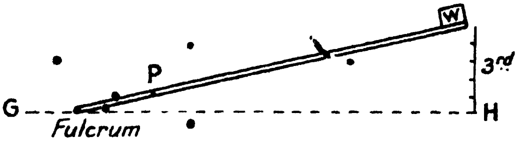


FIG. 3.



When the *Fulcrum* occupies the middle place the lever is of the first rder.

When the *Weight* occupies the middle place it is of the second order.

When the *Power* occupies the middle place it is of the third order.

The three orders are shown in figs. 1, 2 and 3.

We have examples of the first order in the scissors; in the poker when it s rested on the bars while the coal is lifted; in digging with a spade; and ften in the crowbar.

The wheel-barrow is an example of the second order of lever; also the water-wheel, the windmill, nut-crackers, and the oar used in rowing, its broad blade acting as a fulcrum.

The treadle of a grindstone is an example of the third order of levers, so are the tongs and the shears used for shearing sheep.

The amount of power which would be required to lift 100 pounds with a 10 foot lever would vary considerably according to different circumstances, but it can always be calculated by the following rule: As is the distance between the fulcrum and the power, to the distance between the fulcrum and the weight, so will be the weight to the power required to move it.

If in the first order, for example, we use a lever that is 10 feet long, the distance of the fulcrum from the weight being 2 feet, then from the fulcrum to the power will be 8 feet, and putting the weight at 100 pounds, then: As is 8 feet (the distance of the fulcrum from the power) to 2 feet (the distance of the fulcrum from the weight) so will be the weight—100 pounds—to the power required to lift it. This may be expressed as follows, 8 : 2 : : 100 : the answer; therefore 100 multiplied by 2, divided by 8, will show the power required—that is 25 lb.

If (using the same lever) we now move the fulcrum nearer to the power so that instead of being 8 feet away it is only 6 feet, then the fulcrum will be 4 feet from the weight, and by the rule we find that 6 : 4 : : 100 : the answer; hence $100 \times 4 \div 6$, which equals $66\frac{2}{3}$ lb., represents the power which would then be required to move the weight.

It is on this principle that the common steelyard is constructed, the fulcrum remains fixed and the place for suspending the weight is fixed, but the power (the weight which is movable between the fulcrum and free end of the bar) is moved backward or forward on the bar until it balances with that which is being weighed; the weight is marked on the bar, but it could easily be calculated by the rule given.

If it is required to know the weight which could be lifted by a stated power—as for example: What weight could be lifted with 25-lb. power using a 10-foot lever, the fulcrum being 2 feet from the weight-end?—then multiply the given power by the distance between the fulcrum and the power, and divide it by the distance between the fulcrum and the weight; that in this case would be $25 \times 8 \div 2$, the answer being 100 lb.

The same rules are used for any order of lever, but there is a difference in the advantage gained by the different levers, for example: using the same length lever 10 feet) and the same weight (100 lb.) we change the places of the weight and the fulcrum, putting the latter at the end; we now have a lever of the second order, and as is the distance between the fulcrum and the power 10 feet, to the distance between the fulcrum and the weight 2 feet, so will be the weight 100 lb. to the power required to move it; 10 : 2 : : 100 : the answer; this equals $\frac{100 \times 2}{10}$, that is 20 lb. power would in this case lift 100 lb., which is a saving of 20 per cent in power compared with the first order of levers. In racing boats the rowlock in which the oars rest is always fixed as near as possible to the fulcrum (the blade of the oar), because of the advantage gained in power.

In considering the third order of levers we will use the same length lever—10 feet—but it will be seen by the illustration that the power and the weight have changed places. The distance between the fulcrum and the power is now only 2 feet, and that between the fulcrum and the weight is 10 feet, the weight being the same as in the previous examples—100 lb., therefore

$\frac{100 \times 10}{2} = 500$ lb. is the power which would in this case be required to lift 100 lb.

It would seem that the amount of power required in this case would prevent it ever being practically used, but its great advantage is that *what has been lost in power has been gained in time.* By the illustration it may be seen that with the first lever, for the weight to be lifted one space—which would bring it on a line with AB—the end of the lever where the power is applied must move a distance equal to four spaces—from J to B. With the second order of lever, that the weight might be lifted an amount equal to one space above CD, the power has had to move through five times the distance, therefore *time has been sacrificed to gain power.* In the third order of levers it is the reverse, *power being sacrificed to gain time,* since the weight moves through five spaces while the power moves through one space. This is important in the construction of machines where speed is required, the weight being but small, *e.g.* in the "take up" on many of the upper closing machines.

Another important use served by levers is *to change the direction of motion;* with the second and third orders of levers the weight and the power both move in the same direction, whereas in the first order, the weight moves in an opposite direction to the power.

In the common "bell-crank" we have an illustration of how the direction of motion can be changed; its principle is to be found in the mechanisms of very many of our machines. It is a lever of the first order.

The laster's pincers furnish an example of a *double-lever.*

The rivet on which the two handles move is the fulcrum for the two levers of the first order which are used when the upper is gripped between the jaws; the power is applied at the handles, the grip on the upper being the resistance or weight. The advantage gained in power will be according to the ratio of the distance from the fulcrum (rivet) to where the power is applied and the distance from the rivet to the end of the jaws. It should be observed that if instead of gripping the handles by the extreme end they are held nearer the rivet, then the advantage which could have been gained is lost. When the handles are pressed together they are moved in opposite directions, two levers are therefore used in one operation.

When the upper is gripped between the jaws of the pincers, and the "hammer" rested on something solid, the handles being then depressed as they would be in the operation of lasting, we take advantage of another lever of the first order. The advantage gained in power will be according to the ratio of the distances between the fulcrum (the hammer) and the end of the jaws, compared with the distance from the fulcrum to *that part of the handles where the power is applied;* hence the importance of gripping the handles as far away from the hammer as possible.

For the examples of levers in the foot see § 10.

APPENDIX II.

GEOMETRY.

A KNOWLEDGE of the following problems in Geometry is essential, hence they should be mastered before the practical pattern cutting is attempted.

I. *To bisect a given straight line—AB—by its perpendicular bisector* (fig. 1).

With A as centre and any suitable radius, describe arcs as at C and D: then with B as centre and the same radius describe two other arcs so that hey cut the former ones; join the points of intersection by the line CD cutting AB at O. Then

(1) AB is bisected at O.

(2) COD is perpendicular to AB.

(3) Any point on CD is equidistant from A and B.

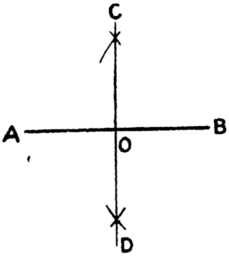


FIG. 1.

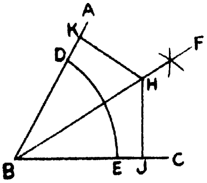


FIG. 2.

Note.—The radius chosen must be greater than half the line or else the arcs will not cut; to see distinctly the exact intersection the radius used should be about equal to the length of the line.

II. *To bisect a given angle, such as ABC* (fig. 2).

With B as centre, and any convenient radius, describe an arc cutting AB and BC, at D and E respectively; then using D and E as centres describe arcs intersecting as at F, and join FB. Then

(1) The angle ABF equals the angle FBC.

(2) If any point is selected on BF (as at H) and two lines from H are drawn, one perpendicular to AB, and the other to BC, then these two lines as HJ and HK will be equal in length.

III. *To divide a straight line into any number of equal parts.*—Say seven (fig. 3).

Let AB be the given line; from A draw a line—AC—making any convenient angle with AB; starting from A mark off with dividers, compass or ruler, the required number (in the present case, 7) of equal distances along AC; join the last one—7—to B; then by means of set squares or parallel ruler draw a line parallel to B7 through each division; these lines will then cut AB, dividing it into 7 equal parts.

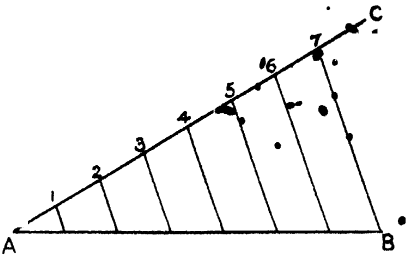


Fig. 3.

Note.—Although any distance may be marked 7 times along AC, care should be taken that it is not so large as to require too much room or so small that the parallels become inconveniently close together (see § 53).

IV. *To describe a circle passing through three given points.*

Let A, B, C (fig. 4) be the three points; proceeding as in problem I. construct the perpendicular bisectors of AB and BC (as DE and FG), producing them until they intersect as at O; then with O as centre and OA as radius a circle can be described passing through ABC.

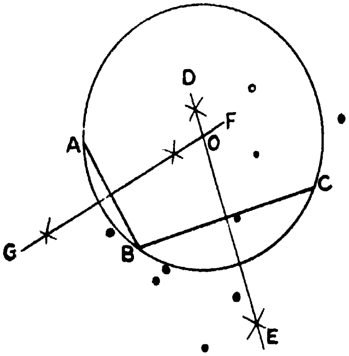


Fig. 4.

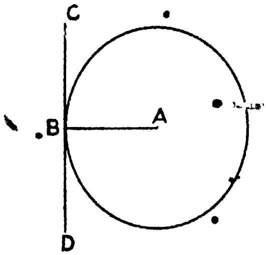


Fig. 5.

V. *To draw a tangent to a given circle at a given point* (fig. 5).

Draw a line from the centre of the circle to the given point on its circumference, as AB, now (with set squares) draw CD perpendicular to it (fig. 5). Then CD is the tangent required.

VI. *To describe an arc passing through a given point and tangential to a straight line at a given point.*

Let A (fig. 6) be the point and BC the straight line, it being required to describe an arc joining BC at B and passing through A. Erect BD perpendicular to BC; now produce the perpendicular bisector of AB (Problem I.) until it cuts BD; the point of intersection—O—will be the centre of the arc (see § 57).

VII. *Given an arc and its centre, to construct another arc passing through a given point, and which shall form a continuous curve with the former arc* (fig. 7).

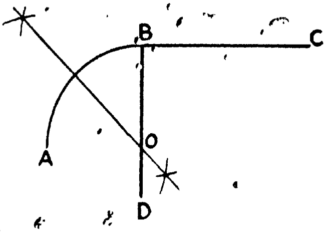


FIG. 6.

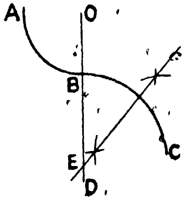


FIG. 7.

Let O be the centre of the given arc AB and C the given point; an arc is required to form a continuous curve with AB at B, and to pass through C which is on the side of AB remote from O; draw a line from O passing through B (as OD), now produce the perpendicular bisector of BC until it cuts OD in E; then an arc with E as centre and EB as radius will pass through C and form a smooth double curve.

Note.—The same construction applies if C be on the same side of FH (fig. 8).

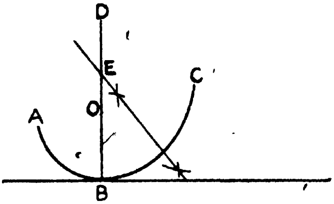


FIG. 8.

VIII. *To construct a tool which will at once show any length line* (within the limits of the tool) *divided into any number of equal parts* (fig. 9).

Draw a line of any suitable length and at one end erect a perpendicular on which mark off any desired number of equal spaces; then connect each mark with the other end of the base line. If now it is required to divide a certain distance into 5 equal parts it will only be necessary to find a point by trial on the fifth line from the base line, such that its perpendicular distance from the base is equal to the line to be divided; if this line be now imagined drawn on the tool it will be found divided as required by the converging lines (see D and E, fig. 9). A similar procedure will divide any other line into any required number of parts within the limits of the tool.

IX. *A readier method is to utilize the lines on ordinary ruled paper;*

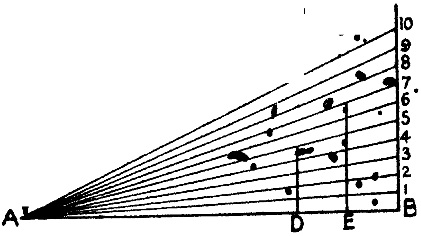


FIG. 9.

for example, suppose it is required to divide a given line into 5 equal spaces; the length of the line to be divided is marked on a strip of paper as AB (fig. 10), one of the marks being made to coincide with one of the ruled lines; the

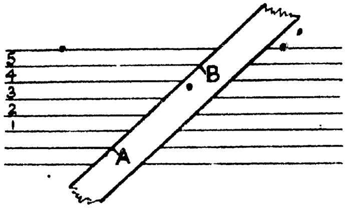


FIG. 10.

strip of paper is now rotated until the second mark coincides with the fifth ruled line, when the exact position of the divisions can be marked.

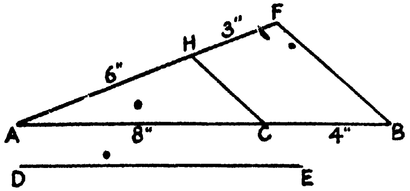


FIG. 11.

X. *Given a position on one line to find its corresponding position on another line which is of different length.*

Let AB represent the first line, the position being C and DE the second line. At any convenient angle draw a line from one end of the line AB and mark on it from the apex of the angle the length of the second line as AF (fig. 11); now connect the ends of the two lines as BF, and parallel with this draw another line from C; where it cuts AF at H that line will be divided in the same proportion as AB. (Note that this is the same principle as is in III., where the positions were equal lengths.)

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